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DRAFT

PRELIMINARY
REMEDIAL INVESTIGATION REPORT
VOLUME 1 OF 2

ECC SITE

ZIONSVILLE SITE

WA18.SL30.0

JULY 27, 1984

NONDISCLOSURE STATEMENT

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Chapter 2

INTRODUCTION

This remedial investigation (RI) report for the Environmental Chemical and Conservation Corporation (ECC) site near Zionsville, Indiana, is prepared in partial satisfaction of Contract No. 68-01-6692, Work Assignment No. 18.5L30.0, and the Final Work Plan (April 1983), Tasks 1 through 5.

PURPOSE OF THE REPORT

This RI report is based, in part, on data obtained during remedial investigation activities conducted from April 1983 through June 1984 at the ECC site. These data and those from other sources are used to define the site problems, identify pathways and receptors, and determine the necessity for and extent of remedial actions at the site.

The purpose of this RI report is threefold: 1) develop and describe applicable remedial alternatives, 2) summarize and present the site investigation analyses and conclusions, and 3) document the details of remedial investigation activities through technical memorandums included in Appendix A.

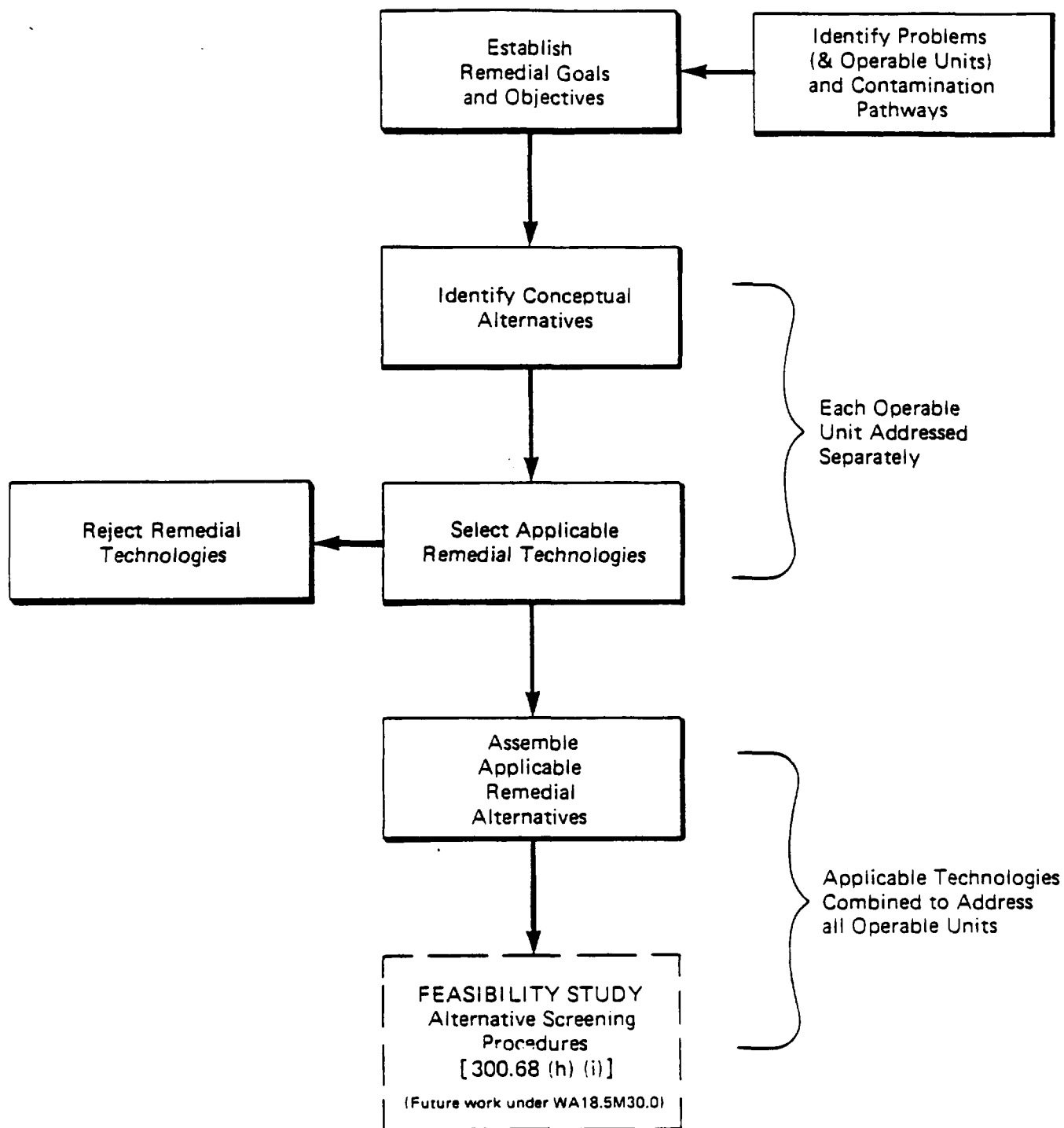
ORGANIZATION OF THE REPORT

This RI report is organized into three main sections. Chapter 3 presents a description of the site and its history. Chapter 4 presents the summary and conclusions of the RI analyses. Chapter 5 presents the methodology and results of the development of applicable remedial alternatives. Volume 2 of 2 presents the appendixes that contain detailed documentation of activities and specific data obtained for each task (refer to the Final Work Plan, April 1983) completed during the RI.

DEVELOPMENT OF APPLICABLE REMEDIAL ALTERNATIVES

Applicable remedial alternatives are developed following the approach shown in Figure 2-1. Guidance was taken from the National Contingency Plan (NCP) and the interim final Advanced Notification Preliminary Draft Interim Guidance on the Preparation of Feasibility Studies, dated September 29, 1983. To clearly understand the process, attention must be given to the terminology, especially "operable units," "conceptual alternatives," "remedial technologies," and "applicable remedial alternatives"; each is specifically defined below and represents a specific step in the development approach. Throughout this development, cost criteria are not applied to identification, selection, or rejection of applicable technologies; only technical feasibility and effectiveness are applied.

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FIGURE 2-1
APPLICABLE REMEDIAL ALTERNATIVE
DEVELOPMENT SCHEMATIC [300.68 (g)]
ECC RI REPORT

Operable units are defined to group site problems into specific areas of concern. For the ECC site, the defined operable units include soil, groundwater, surface water, and sediments. Pathways of contamination are the natural movement of contaminants from, within, and between operable units. The problems and pathways of contamination are receptor-oriented; each operable unit is considered in relation to potential receptors of contamination.

In general, the goal of every alternative is to mitigate and minimize damage to and provide adequate protection of public health, welfare, and the environment [40 CFR 300.68(j)].

Conceptual remedial alternatives are general response actions that address site problems and pathways of contamination. These conceptual remedial alternatives are identified and carried forward for development into more detailed applicable remedial alternatives.

After conceptual alternatives are identified, applicable remedial technologies are selected using best engineering judgment for each alternative. These technologies are the specific techniques needed to implement each of the conceptual alternatives. Rejection of any remedial technology is based on three criteria:

- o Physical site constraints

- o Chemical or physical limitations
- o "Proven" nature of the technology

The final step is the assembly of selected remedial technologies into applicable remedial alternatives. Because of the large number of potential assembled remedial alternatives, assembly of remedial alternatives will be performed during the feasibility study (to be conducted under Tasks 1 and 2 of WA 18.5M30.0.

ANALYSIS OF SITE INVESTIGATIONS

The analysis of site investigations conducted at ECC from April 1983 through July 1984 is organized by the operable units. The analysis provides the technical basis for identification of problems and pathways of contamination for each operable unit.

RI ACTIVITY TECHNICAL MEMORANDUMS

Each RI activity is described in a technical memorandum (TM) issued during the course of RI work. These TM's are contained in Appendix A of this report. Each TM describes specific procedures, observations, measurements, data results, etc., of RI activities.

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Chapter 3

SITE BACKGROUND

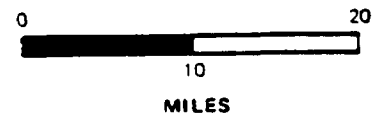
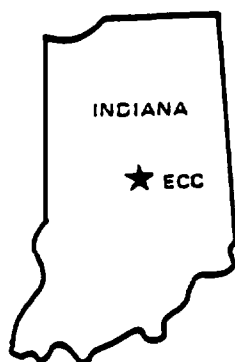
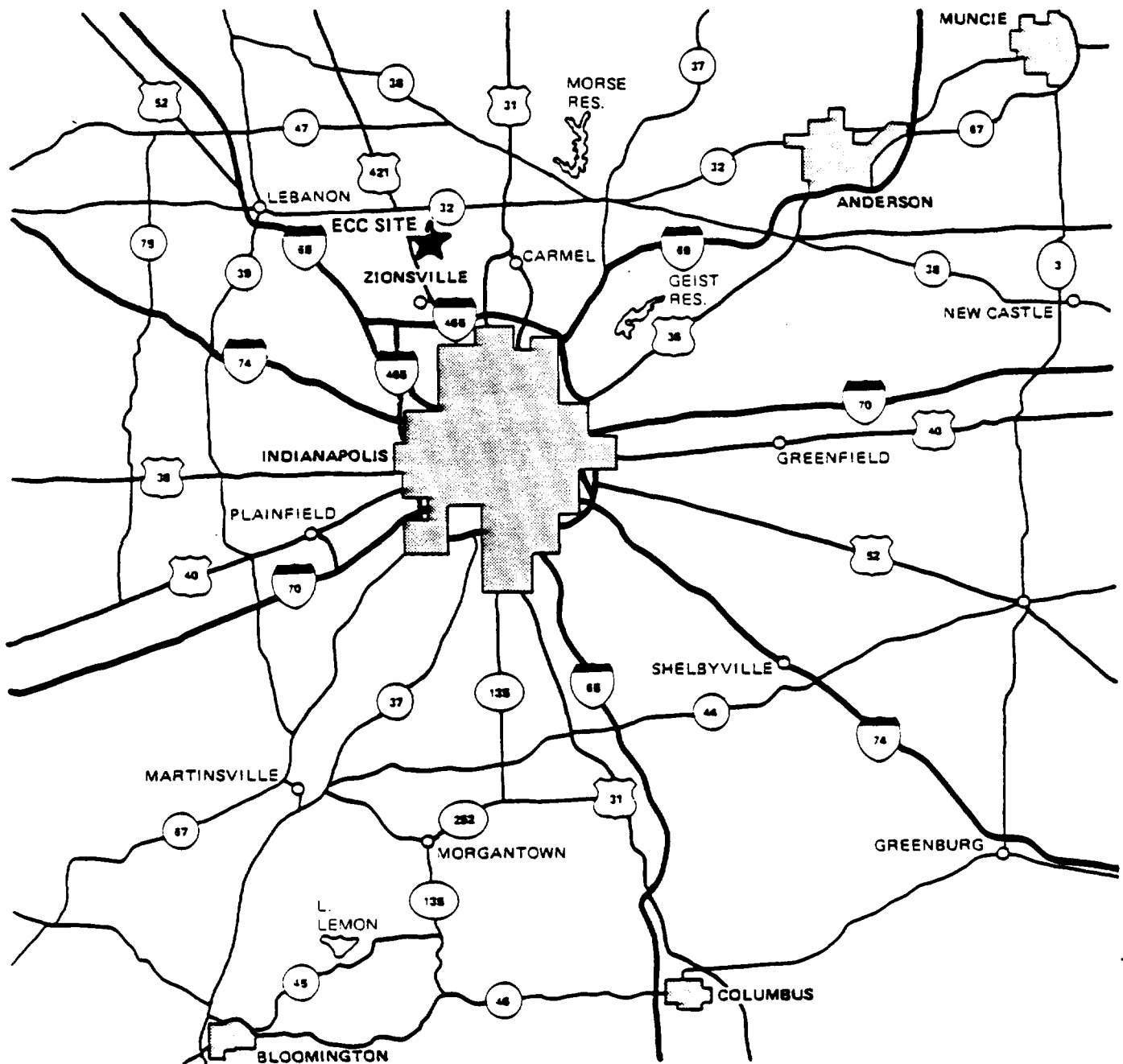
SITE DESCRIPTION

Environmental Conservation and Chemical Corporation is in Boone County, 865 south U.S. 421, Zionsville, Indiana, about 10 miles northwest of Indianapolis (Figure 3-1). The site occupies 6.5 acres alongside the 168 acre Northside Sanitary Landfill (NSL), an ongoing solid waste disposal facility permitted by the Indiana Stream Pollution Control Board (SPCB) (Figure 3-2).

The ECC facility is bounded on the south and east by the landfill. A site map is shown in Figure 3-3. An unnamed ditch separates the two facilities along the east boundary. The site is bounded on the north and west sides by several residential homes, located within one-half mile of the facility.

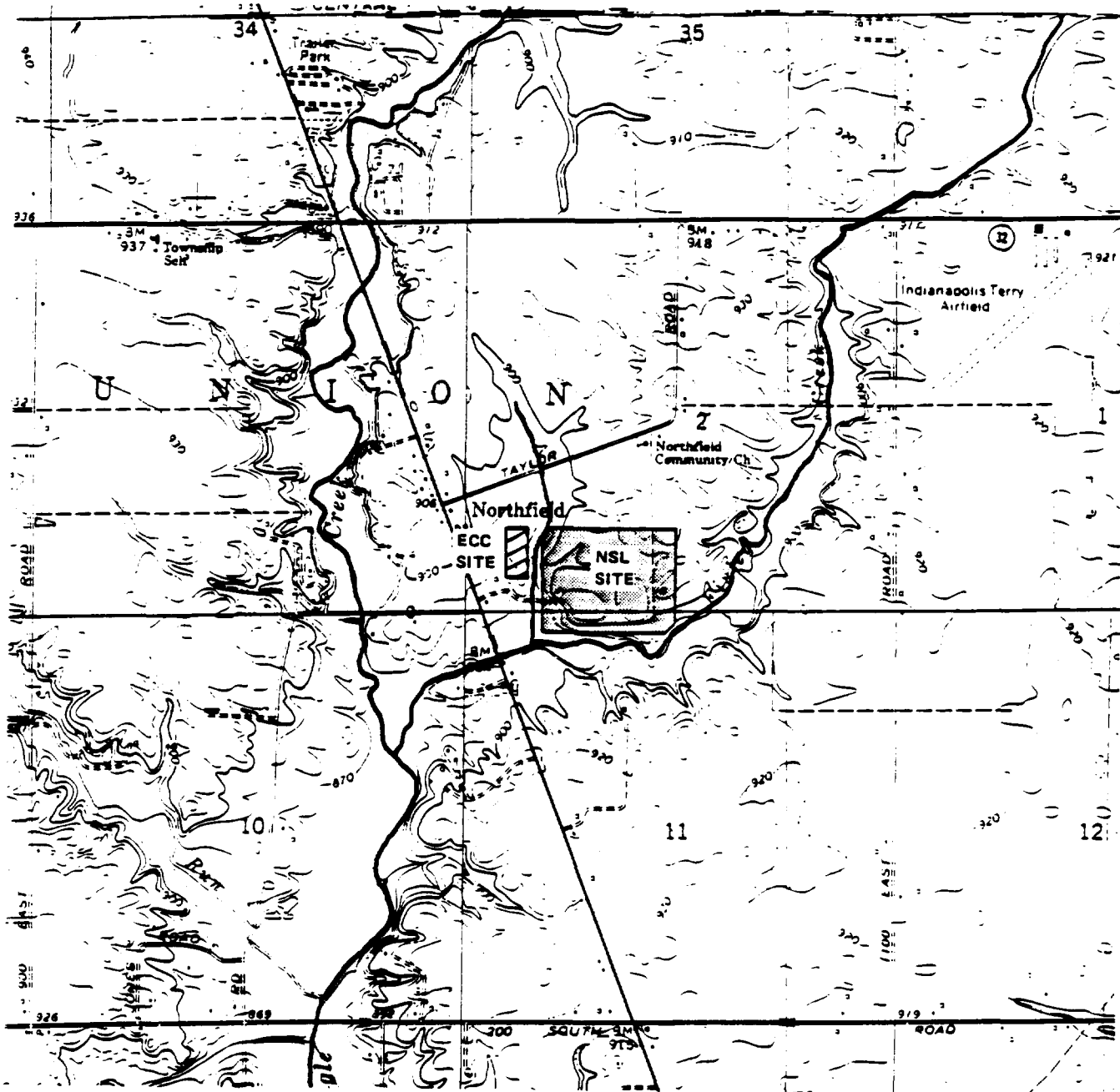
SITE HISTORY

The Environmental Conservation and Chemical Corporation began operation in August of 1977 under a construction permit issued by the Indiana Air Pollution Control Department (APCD) on May 5, 1977. The company was engaged



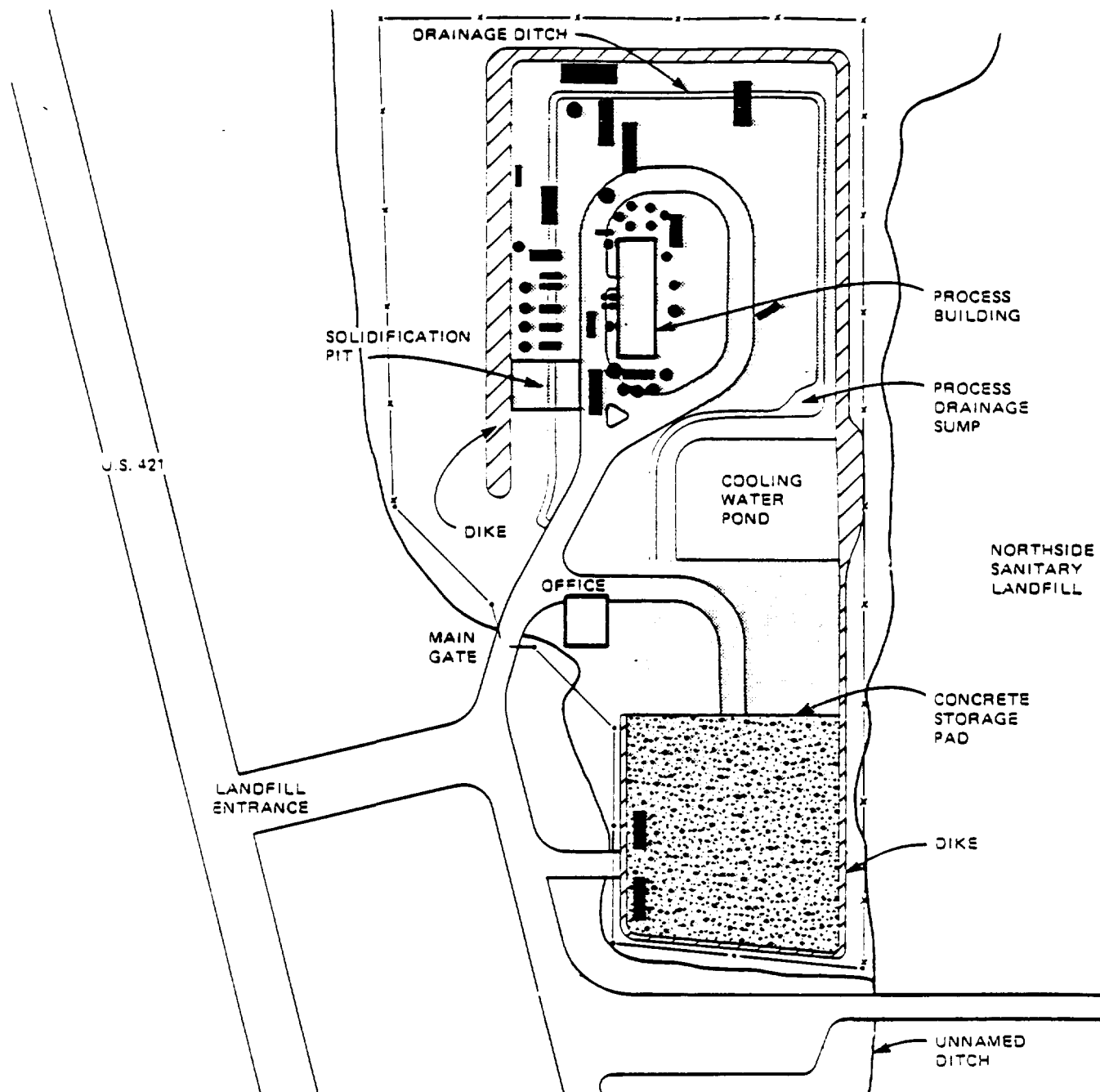
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**FIGURE 3-1
LOCATION MAP
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





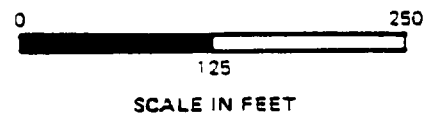
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FIGURE 3-2
VICINITY MAP
ECC RI REPORT



LEGEND

-  DRUM STORAGE AREA
-  TANKS
-  WOOD FENCE
-  STRANDED WIRE FENCE
-  CONCRETE PAD
-  EARTHEN DIKE



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FIGURE 3-3
SITE MAP (1982)
ECC RI REPORT

in the recovery/reclamation/brokering of primary solvents, oils and other wastes received from industrial clients. Waste products were received in drums and bulk tankers and prepared for subsequent reclamation or disposal. Reclamation processes included distillation, evaporation and fractionation to reclaim solvents and oil.

Two problems developed during the facility's operation:

- o The inability of the company to adequately dispose of wastewater and contaminated stormwater generated at the facility,
- o The inability of the company to manage its drum inventory in a manner that did not pose a threat to the environment.

In an attempt to handle the wastes generated onsite, approval was sought by ECC to dispose of 5,000 gallons per day of oil recovery wastes and 1,000 to 1,500 gallons per week of still bottoms at NSL. Approval to dispose of the still bottoms was granted (with conditions) by the SPCB on October 11, 1977; however, the request to dispose of the liquid waste from the oil recovery operations was denied.

Subsequently, the company sought other avenues of waste disposal. An agreement was reached between the Indiana State

Board of Health (ISBH), ECC, and NSL to allow disposal of oily wastes in the landfill with municipal refuse. Following expiration of this agreement in May 1979, ECC added units to process wastewater by distillation onsite. The product water was used as boiler makeup water.

On July 31, 1979, the ISBH received a report from a private citizen that an oil spill had occurred on Eagle Creek north of Zionsville. Immediate inspection revealed that the oil had originated from ECC and a minor amount from NSL. ECC agreed to take action to recover the oil. A followup investigation conducted on August 2, 1979 by the ISBH showed that ECC intentionally discharged process and cooling water from a storage lagoon into Finley Creek without a permit. ECC officials explained that due to heavy rains, stormwater pumped from the drum storage and loading areas to the cooling water pond caused it to overflow. Therefore, it became necessary to drain the excess water.

On September 18, 1979, the SPCB met to discuss the spill and discharge incidents at ECC. The board ratified an Agreed Order that included a fine and provisions to upgrade the methods of recordkeeping at the facility. In November 1979, the SPCB began a water sampling and analysis program at the site. Cooling water pond samples taken on November 2, 1979 were found to contain relatively high concentrations of arsenic, cadmium, chromium, lead, nickel, oil and grease,

phenol, and zinc. Further testing of area wells and streams were inconclusive in documenting contamination of groundwater and surface water.

In December 1979, the U.S. EPA designated ECC as a potential hazardous waste site and began investigations under the Hazardous Materials Emergency Response Program. By April 17, 1980, the ISBH submitted documentation to the Indiana Environmental Management Board (EMB) concerning ECC violations of the Environmental Management Act, the Air Pollution Control Law and the Stream Pollution Control Law. Specifically, the staff documented that:

- o ECC posed a threat to pollute the environment.
- o The company was burning chlorinated hydrocarbons and other solvents as boiler fuel without approval.
- o Process water and contaminated stormwater were discharged without approval.
- o Spills of oil and other objectionable substances occurred and were not reported or effectively cleaned up.

Based on these violations, the EMB referred the matter to the Office of the Attorney General on May 15, 1980 for appropriate enforcement.

On February 9, 1981, an ECC employee died of exposure to toxic vapors after entering a solvent tanker.

A Consent Decree was issued on July 1, 1981, by the Boone County Circuit Court imposing a \$50,000 civil penalty against ECC. Furthermore, the court placed ECC into receivership and prohibited the company from using NSL for disposal of wastes. The decree gave ECC until November 1, 1982 to comply with environmental laws and regulations.

At this point, the ISBH began weekly monitoring of ECC's drum storage area to insure that action was being taken to reduce barrel inventory and improve storage facilities. The area was found to be extremely overcrowded with drums, some of which were damaged and leaking. Access was also dangerously poor. By October of 1981, construction of a concrete drum storage pad was underway and drum inventory had been reduced to an estimated 20,000 barrels. By December, the number of leaking, formerly leaking, popped top, corroded/damaged, and bungless/open top drums had been reduced to about 225. In February 1982, the EMB placed a freeze on drum shipments to the facility before the Boone County Circuit Court to assure compliance with the Consent

Decree regarding storage of drums, location of materials onsite and in transit, and the removal of sludge.

On May 5, 1982, ECC was ordered by the court to close and environmentally secure the site for failure to reduce hazardous waste inventories. Two days later ECC's court receiver filed a closure plan with the Boone County Circuit Court. By August 1982, ECC was found to be insolvent and planning work had begun for environmental revitalization, cleanup, and recycling of the site.

On September 21, 1982, the Office of the Attorney General held a conference with the ISBH and representatives from 60 generators of waste to propose a voluntary cleanup plan for the ECC site. The closure plan and settlement offer required generators to remove and dispose of wastes and pay \$250/drum into a trust fund to be used for remaining surface/subsurface remedial measures. In return, generators would receive a limited release. In response to the offer, the generators entered into a loose coalition and hired Chemical Waste Management, Inc., to prepare a technical proposal for a complete surface cleanup which was accepted and is now nearing completion.

PREVIOUS INVESTIGATIONS

Sampling and testing efforts were conducted at ECC from 1976 through 1982. Sources of data were primarily laboratory data sheets or handwritten data summary tables, generally unaccompanied by descriptions of the sampling and testing procedures used. As such, much of this historical data summarized herein could not be used as a basis for definitive interpretations of existing conditions onsite or offsite at ECC. Rather, the data could be used in qualitative assessments of contamination and in determining locations where further testing would be needed. For locations where sampling, testing and quality control procedures were well documented, additional sampling might not be necessary.

Historical sampling and testing information for ECC is discussed under the following headings:

- o Onsite surface water and sediment
- o Offsite surface water and sediment
- o Groundwater
- o Residential well water
- o Soil
- o Aquatic biota

ONSITE SURFACE WATER AND SEDIMENT

Sampling and Testing

Table 3-1 summarizes the known surface water and sediment sampling events that took place onsite at ECC before REM/FIT activities began. Three general locations have been sampled: the cooling water pond, the north drum storage area pond, and the south drum storage area pond.

Sampling and testing procedures were not described for any of the events listed. However, all EPA samples were analyzed by labs selected and certified as part of the Contract Laboratory Program (CLP). Standard procedures are utilized by these labs for the analysis of organic and inorganic priority pollutants.

All of the ISBH samples were analyzed by the ISBH Water Laboratory. The lab analyzed blanks and surrogate spikes with each set of samples. Duplicates were only occasionally analyzed.

Results

Analytical results are summarized in Tables 3-2 and 3-3. Table 3-2 presents the data for samples upon which only a limited analysis was performed. Table 3-3 summarizes the data for samples exposed to a more extensive analytical testing program.

Table 3-1
HISTORICAL ONSITE SURFACE WATER AND SEDIMENT SAMPLING
ECC SITE

| Sampler | Sampling Date | Analytical Laboratory | Document Number | Sampling Location | No. of Samples | | Parameters Analyzed | Data Summary |
|---------|---------------|--|-----------------|---|----------------|----------|---|--------------|
| | | | | | Water | Sediment | | |
| ISBH | 3/2/79 | Water Laboratory, ISBH | 24 | Cooling water pond | 1 | | COD, Pb, Hg, oil, phenol | Table 3-2 |
| ISBH | 6/8/79 | Water Laboratory, ISBH | 23 | Cooling water pond; south storage area | 2 | | As, Cd, Cr, Pb, Hg, Ni, Zn, oil, phenol, Cu | Table 3-2 |
| ISBH | 8/2/79 | Water Laboratory, ISBH | 33 | Cooling water pond; south storage area | 1 | | Oil, BOD, COD, Pb, Ni, Zn | Table 3-2 |
| ISBH | 11/2/79 | Water Laboratory, ISBH | 35 | Cooling water pond; north and south storage areas | 5 | | As, Cd, Cr, Pb, Hg, Ni, Zn, oil, phenol, pH | Table 3-2 |
| ISBH | 4/3/80 | Water Laboratory, ISBH & Industrial Hygiene Laboratory | 45 | South storage area | 1 | | PCB, Cd, Cr, Ni, Pb, Zn, Cu, phenol | Table 3-2 |
| EPA | 4/10/80 | CLP ^a ; W. Coast Technical Service, Inc. | 47 | Cooling water pond; south storage area | 2 | | Organic priority pollutants | Table 3-3 |
| ISBH | 4/17/80 | Water Laboratory, ISBH | 48 | North and south storage areas | 2 | | As, Cd, Cr, COD, Cu, Pb, Ni, pH, phenol, Zn | Table 3-2 |
| ISBH | 3/10/81 | Water Laboratory, ISBH | 113 | Cooling water pond | 1 | 1 | Metals, PCB's, volatile organics, others | Table 3-3 |
| ISBH | 4/29/81 | Water Laboratory, ISBH | 104 | South storage area | 2 | | Phenol, TOC, oil, volatile organics | Table 3-2 |
| EPA | 8/9/82 | CLP | 181 | Cooling water pond | 1 | | Organic priority pollutants | Table 3-3 |
| EPA | 10/18/82 | CLP | 209 | Cooling water pond; north and south storage areas | 4 | 1 | Organic and inorganic priority pollutants | Table 3-3 |

^a CLP = Contract Laboratory Program

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Table 3-2
HISTORICAL ONSITE SURFACE WATER
SAMPLING RESULTS (ppb)
ECC SITE

| Water Quality Parameter | Cooling Water Pond | | | | South Drum Storage Area Pond | | | | | | North Drum Storage Area Pond | | | EPA Water Quality Criteria ^a |
|----------------------------|--------------------|------------|-----------|----------|------------------------------|----------|----------|-----------|----------|----------|------------------------------|-----------|-------------|---|
| | 03/02/79 | 06/08/79 | 08/02/79 | 11/02/79 | 06/08/79 | 11/02/79 | 11/02/79 | 04/03/80 | 04/17/80 | 04/29/81 | 11/02/79 | 11/02/79 | 04/17/80 | |
| Arsenic | | 4 | | 11 | 1 | 6 | 4 | | 18 | | 60 | 900 | 7 | 0.022 ^{c,d} |
| Cadmium | | < 20 | | < 10 | < 10 | 40 | 160 | 70 | 30 | | 10 | 300 | 17 | 10 ^b |
| Chromium | | 390 | | < 10 | 1,100 | 40 | 250 | 770 | 380 | | 1.6 | 104,000 | 1,000 | 50 ^{b,e} |
| Lead | 31,000 | 520 | 80 | < 20 | 80 | 90 | 80 | 110 | 40 | | 0.3 | 66,000 | 310 | 50 ^b |
| Mercury | < 10,000 | | | < 0.5 | | < 0.5 | < 0.5 | | | | 0.9 | < 200 | | 0.144 ^b |
| Nickel | | 230 | 70 | 40 | 40 | 50 | 120 | 160 | 140 | | 90 | 500 | 30 | 13.4 ^b |
| Zinc | | 580 | 290 | 150 | 2,300 | 140 | 260 | 290 | 90 | | 1,090 | 18,000 | 3,100 | NCA |
| Copper | | | | | | | | 460 | 838 | | | | 11,100 | NCA ^b |
| Phenol | 8,800 | | | 65,300 | 28,000 | 22,500 | 25,500 | 22,400 | 13,000 | 10,000 | 35 | 3,000,000 | 8,900 | 3,500 ^b |
| Oil | 80,000,000 | 18,000,000 | 8,300 | 20,000 | 110,000 | 180,000 | 63,000 | | | 62,400 | 3,032,000 | | | -- |
| pH | | | | 6.3 | 2.0 | 7.3 | 7.2 | | 6.9 | | 7.1 | | 7.1 | -- |
| BOD | | | 1,800,000 | | | | | | | | | | | -- |
| COD | 26,000,000 | | | | | | | 5,700,000 | | | | | 430,000,000 | -- |
| TOC | | | 6,000,000 | | | | | | | 910,000 | | | | -- |
| PCB | | | | | | | | 3.5 | | | | | | 0.00079 ^c |

NCA = Insufficient data available upon which to derive a criterion.

Blank indicates parameter not analyzed.

^a For the protection of human health assuming a daily ingestion of 2 liters of water, 1980.

^b Toxicity criteria.

^c Carcinogenicity criteria at the 10⁻⁵ risk level.

^d Criteria applies to total trivalent arsenic.

^e Criteria applies to total hexavalent chromium.

^f Oil layer.

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The following inorganic chemicals were detected in the cooling water pond water samples at levels above EPA Water quality criteria:

- o Cadmium
- o Lead
- o Mercury
- o Nickel

A sample of the surficial oil layer from the north storage area pond taken on November 2, 1979, was found to contain arsenic, cadmium, chromium, lead, nickel, and zinc far in excess of the levels found for the pond water samples.

Listed in Table 3-3 are the organic priority pollutants found in at least one of the pond water samples above the detection limits. Background levels for these compounds are generally < 1 ppb. The following eleven substances were found in the pond water samples at levels above EPA water quality criteria:

- o 1, 1, 2 Trichloroethane
- o 1, 1, Dichloroethene
- o Tetrachloroethene
- o Trichloroethene
- o Methylene chloride
- o Chloroform

Table 3-3
HISTORICAL ONSITE SURFACE WATER AND SEDIMENT
SAMPLING RESULTS (ppb)
ECC SITE

| Organic Priority Pollutants | Cooling Water Pond | | | | | South Drum Storage Area Ponds | | | North Drum Storage Area Pond | EPA Water Quality Criteria ^a |
|--------------------------------|--------------------|----------|----------|----------|----------------------|-------------------------------|-----------------------|----------|---------------------------------|---|
| | 04/10/80 | 03/10/81 | 08/09/82 | 10/18/82 | Sediment 03/10/81 | 04/10/80 | 04/29/81 ^f | 10/18/82 | 10/18/82 | |
| 1,1,-Dichloroethane | ND | 4.4 | 17 | ND | 70 | ND | < 5 | ND | ND | NCA |
| 1,1,1-Trichloroethane | 6,821 | < 900 | 831 | 1,322 | 730 | ND | 160 | 621 | 1,266 | 18,400 ^b |
| 1,1,2-Trichloroethane | 16 | | < 2.8 | | | ND | < 5 | | | 6.0 ^c |
| 1,1-Dichloroethene | 152 | < 300 | 95 | ND | | ND | < 5 | ND | ND | 0.33 ^c |
| 1,2-Dichloroethene | 259 | < 50 | 2,022 | 2,848 | 230 | 48 | | 1,541 | 2,766 | NCA |
| Tetrachloroethene | 1,297 | 190 | 12 | 0.6 | < 100 | ND | 260 | 1,176 | 71 | 8 ^c |
| Trichloroethane | 3,873 | < 600 | 191 | 673 | 470 | ND | 320 | 1,176 | 1,398 | 27 ^c |
| Methylene Chloride | 5,470 | 240 | 1,329 | 3,908 | 1,500 | 485 | 180 | 3,873 | 5,548 | 1.9 ^c |
| Chloroform | ND | 59 | 21 | ND | 90 | < 10 | 9.1 | ND | ND | 1.9 ^c |
| Trichlorofluoromethane | ND | | < 2.7 | | | 14 | < 5 | | | 1.9 ^c |
| Toluene | 2,700 | 4,100 | | | 630 | 935 | 600,000 | | | 14,300 ^b |
| Nitrophenol | 270 | | < 59 | | | ND | | | | NCA |
| Pentachlorophenol | 38 | | < 170 | | | 103 | | 5 | ND | 1,010 ^b |
| Phenol | 1,930 | 1,200 | 15,000 | 396 | < 200 | ND | | 460 | 325 | 3,500 ^b |
| 2,4-Dimethylphenol | ND | | 260 | 251 | | 349 | | 236 | 121 | NCA |
| 2,4,6-Trichlorophenol | ND | | < 62 | 5 | | ND | | 4 | 3 | 12 ^c |
| Benzene | ND | < 300 | < 0.5 | ND | 90 | ND | < 8 | ND | 463 | 6.6 ^c |
| Methylbenzene | ND | | 858 | 974 | | ND | | 1,035 | 1,132 | -- |
| Ethylbenzene | ND | 600 | 110 | ND | 330 | 1,188 | 310 | ND | ND | 1,400 ^b |
| 1,3-Dimethylbenzene | ND | | 98 | ND | | ND | | ND | ND | -- |
| 1,2 & 1,4-Dimethylbenzene | ND | | 79 | ND | | ND | | ND | ND | -- |
| 1,3-Dichlorobenzene | ND | | < 25 | 0.5 | | ND | | 17 | 92 | 400 ^b |
| 1,4-Dichlorobenzene | ND | | < 22 | 0.4 | | ND | | 15 | 86 | 400 ^b |
| 1,2-Dichlorobenzene | ND | | < 25 | 0.5 | | 27 | | 18 | 97 | 400 ^b |
| Diethylphthalate | 27 | | 86 | 47 | | 433 | | 32 | ND | 350,000 ^b |
| Dimethylphthalate | 311 | | 240 | 175 | | 513 | | 169 | 164 | 313,000 ^b |
| Butylbenzylphthalate | ND | | < 290 | 1,122 | | ND | | 3,277 | 2,457 | NCA |
| Di-n-butylphthalate | < 10 | | 76 | 29 | | < 10 | | 87 | 135 | 34,000 ^b |
| Napthalene | ND | | < 23 | 12 | | ND | | 16 | 29 | NCA |
| Isophorone | ND | | 3,200 | ND | | ND | | ND | ND | 5,200 ^b |
| P-Chloro-M-Cresol | ND | | | | 2,600 | 91 | | | | NCA |
| PCB's | | < 50 | | | | | | | | 0.00079 ^c |

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Table 3-3 (Continued)

| Organic Priority Pollutants | Cooling Water Pond | | | | Sediment 03/10/81 | South Drum Storage Area Ponds | | | North Drum Storage Area Pond 10/18/82 | EPA Water Quality Criteria ^a |
|--------------------------------|--------------------|----------|----------|----------|----------------------|-------------------------------|-----------------------|----------|---|---|
| | 04/10/80 | 03/10/81 | 08/09/82 | 10/18/82 | | 04/10/80 | 04/29/81 ^f | 10/18/82 | | |
| Arsenic | | 4.7 | | 6.0 | 10,000 | | | 5.9 | 5.7 | 0.022 ^{c,d} |
| Cadmium | | 12 | | 3.07 | | | | 5.59 | 9.81 | 10 ^b |
| Chromium | | 150 | | 286 | 19,000 | | | 326 | 320 | 50 ^{b,e} |
| Lead | | 120 | | < 70 | 14,000 | | | 96.0 | 179 | 50 ^b |
| Mercury | | 0.2 | | < 0.1 | 30 | | | | | 0.144 ^b |
| Nickel | | 30 | | 184 | 18,000 | | | | 169 | 13.4 ^b |
| Zinc | | 390 | | 397 | 54,000 | | | 956 | 1,510 | NCA |
| Copper | | 300 | | 29.8 | 26,000 | | | 72.3 | 124 | NCA |
| Aluminum | | 900 | | 1,190 | 10,000,000 | | | 2,770 | 3,030 | -- |
| Barium | | | | 138 | | | | 172 | 183 | -- |
| Beryllium | | < 10 | | < 1 | 700 | | | < 1 | < 1 | 0.068 ^c |
| Cobalt | | | | 13.6 | | | | 25.7 | 34.3 | -- |
| Iron | | | | 6,840 | | | | 14,600 | 19,800 | -- |
| Manganese | | | | 2,370 | | | | 2,370 | 1,960 | -- |
| Boron | | | | 712 | | | | 684 | 389 | -- |
| Vanadium | | | | 8.6 | | | | 13.3 | 12.6 | -- |
| Silver | | | | < 3 | | | | < 3 | < 3 | 50 ^b |
| Antimony | | | | 2.2 | | | | < 2 | < 2 | 146 |
| Thallium | | | | < 2 | | | | < 2 | < 2 | 13 ^b |
| Tin | | | | < 40 | | | | < 40 | 62.6 | -- |
| Ammonia | | 200 | | 5,290 | < 100 | | | | | -- |
| Cyanide | | 52 | | 16 | < 625 | | | | | 200 ^b |

ND = Not Detected.

NCA = Insufficient data available upon which to derive a criterion.

Blank indicates parameter not analyzed.

^a For the protection of human health assuming a daily ingestion of 2 liters of water, 1982.^b Toxicity criteria.^c Carcinogenicity criteria at the 10⁻⁵ risk level.^d Criteria applies to total trivalent arsenic.^e Criteria applies to total hexavalent chromium.^f Oil layer.

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- o Trichlorofluoromethane
- o Toluene
- o Phenol
- o Benzene
- o PCB's

Each of the onsite surface water areas sampled were found to contain levels of organic priority pollutants exceeding EPA water quality criteria.

One sample of the cooling water pond sediment was tested by the EPA. Inorganic pollutants reported in levels above background levels in sediment were arsenic, aluminum, chromium, nickel and copper. Organic pollutants reported in levels above background were 1, 1, dichloroethane, 1, 1, 1, trichloroethane, 1, 1, dichloroethene, trichloroethene, tetrachloroethene, methylene chloride, chloroform, toluene, benzene, ethylbenzene and PCB's.

OFFSITE SURFACE WATER AND SEDIMENT

Sampling and Testing

Table 3-4 summarizes offsite surface water and sediment sampling events at ECC. The majority of sampling has been performed by the ISBH. The U.S. EPA performed one sampling episode. The United States Geologic Survey (USGS) performed

Table 3-4
HISTORICAL OFFSITE SURFACE WATER AND SEDIMENT SAMPLING
ECC SITE

| Sampler | Sampling Date | Analytical Laboratory | Document Number | Sampling Location ^a | No. of Samples | | Chemicals Analyzed | Data Summary |
|--------------|---------------|---|-----------------|---------------------------------------|----------------|----------|--|--------------|
| | | | | | Water | Sediment | | |
| John Bankert | 9/15/76 | O.A. Laboratories | 19 | Creek ^b | 1 | | pH, COD, Fe, Cr, Ni, Pb, Zn, Cd, Cl ⁻ | None |
| ISBH | 6/8/79 | Water Laboratory, ISBH | 23 | E | 3 | | As, Cd, Cr, Pb, Hg, Ni, oil, pH, phenol, Zn, PCB | Table 3-5 |
| ISBH | 7/31/79 | Water Laboratory, ISBH | 33 | Finley Cr, Unnamed Ditch, Eagle Creek | 5 | | Oil | None |
| ISBH | 8/2/79 | Water Laboratory, ISBH | 33 | E, F | 2 | | Oil, BOD, COD, Pb, Ni, Zn | Table 3-5 |
| ISBH | 11/2/79 | Water Laboratory, ISBH | 35 | E, K | 2 | | As, Cd, Cr, Pb, Hg, Ni, oil, pH, phenol, Zn | Table 3-5 |
| FPA | 4/10/80 | CLP - W. Coast Technical Services, Inc. | 47 | E, J, K | 3 | | Organic priority pollutants | Table 3-6 |
| ISBH | 4/17/80 | Water Laboratory, ISBH | 48 | C, G, H, K | 4 | | As, Cd, Cr, Cu, Pb, Ni, Zn, COD, pH, phenol | Table 3-5 |
| ISBH | 8/25/80 | Water Laboratory, ISBH | 65A | A, B, L, M | 4 | | PCB, As, Cu, Pb, Zn, diazinon | Table 3-5 |
| USGS | 8/25/80 | USGS Laboratory | 240 | A, C, D, P | | 11 | Metals, pesticides, PCB, others | Table 3-7 |
| ISBH | 3/10/81 | Water Laboratory, ISBH | 113 | A, C, E, N, P, Q, R | 13 | 14 | Metals, pesticides, PCB, volatile organics, others | Tables 3-6&7 |
| ISBH | 9/4/81 | Water Laboratory, ISBH | 137 | B, E, H, I | 4 | | Oil | None |
| ISBH | 10/30/81 | Water Laboratory, ISBH | 149 | D | 1 | | Organic priority pollutants | Table 3-6 |
| USGS | 10/26/82 | USGS Laboratory | 240 | A, P, S | 4 | 4 | Organic and inorganic priority pollutants | Tables 3-6&7 |
| USGS | 12/14/82 | USGS Laboratory | 240 | A, S | 3 | | Organic and inorganic priority pollutants | Table 3-6 |

^a See Figures 3 and 4 for sample locations.

^b Sampling location unknown.

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three sampling episodes, collecting a total of 7 water samples and 15 sediment samples.

Sampling and testing procedure documentation was not found with any ISBH or EPA data. Testing procedures are known only in the general sense described earlier. Sampling and testing procedures employed by the USGS along with complete analytical results are described in: "Water and Streambed Material Data, Eagle Creek Watershed, Indiana, August 1980 and October and December 1982," Open File Report 83-215.

Results

Analytical results for the offsite surface water samples are summarized in Tables 3-5 and 3-6. Figure 3-4 indicates sampling locations. Table 3-5 presents data for surface water samples where only a limited analysis was performed. Table 3-6 summarizes data for samples where a more extensive analysis was performed. Data are presented for only those water quality parameters that had reported levels higher than upstream levels for at least one location.

Two inorganic chemicals were detected in offsite surface waters above EPA water quality criteria levels. Lead was found at sampling location B (downstream of the confluence of the unnamed ditch and Finley Creek) at 80 ppb and at sample location Q (a small tributary to the unnamed ditch

Table 3-5
HISTORICAL OFFSITE SURFACE WATER
SAMPLING RESULTS (ppb)
ECC SITE

| Water Quality Parameter | SAMPLE LOCATIONS DOWNSTREAM OF ECC | | | | | | | | SAMPLE LOCATIONS UPSTREAM OF ECC | | | | EPA Water Quality Criteria ^a | |
|----------------------------|------------------------------------|----------|-----------|----------|----------|----------|----------|-----------|----------------------------------|----------|----------|----------|---|----------------------|
| | A | B | C | E | | | F | G | H | K | L | M | | |
| | 08/25/80 | 08/25/80 | 04/17/80 | 06/08/79 | 08/02/79 | 11/02/79 | 08/02/79 | 04/17/80 | 04/17/80 | 11/02/79 | 04/17/80 | 08/25/80 | | 08/25/80 |
| Arsenic | 1 | 3 | 3 | 4 | | 3 | | 18 | 1 | 1 | | 2 | ND | 0.022 ^{c,d} |
| Cadmium | | | 2 | < 10 | | < 10 | | < 2 | < 2 | | < 2 | | | 10 ^b |
| Chromium | 10 | 60 | 160 | < 10 | | < 10 | | < 10 | < 10 | < 10 | < 10 | 13 | 10 | 50 ^{b,e} |
| Lead | 50 | 80 | 20 | < 20 | < 20 | 20 | < 20 | < 20 | < 20 | < 20 | < 20 | 30 | 20 | 50 ^b |
| Mercury | | | | < 0.1 | | < 0.1 | | | | < 0.1 | | | | 0.144 ^b |
| Nickel | | | 10 | 20 | < 20 | 20 | < 20 | 10 | < 10 | 20 | < 10 | | | 13.4 ^b |
| Zinc | 76 | 79 | 80 | 20 | < 20 | < 20 | < 20 | 10 | < 10 | 20 | < 10 | 70 | 148 | NCA |
| Copper | | | 65 | | | | | 6 | 4 | | < 4 | | | NCA |
| Phenol | | | 9,800 | 2,000 | | < 5 | | 1,500 | < 5 | 7 | < 5 | | | 3,500 ^b |
| Oil | | | | 3,400 | < 1 | 2,800 | < 1 | | | 42,000 | | | | -- |
| pH | | | 7.2 | 1.7 | | 7.2 | | 6.8 | 7.7 | 7.3 | 7.7 | | | -- |
| BOD | | | | | 22,000 | | 22,000 | | | | | | | -- |
| COD | | | 1,500,000 | | 46,000 | | 40,000 | 1,600,000 | 17,000 | | 9,000 | | | -- |
| PCB | 120 | 10 | | < 0.1 | | | | | | | | 10 | 1 | 0.00079 ^c |

ND = Not detected.

NCA = Insufficient data available upon which to derive a criterion.

Blank indicates parameter not analyzed.

^a For the protection of human health assuming a daily ingestion of 2 liters of water, 1982.

^b Toxicity criteria.

^c Carcinogenicity criteria at the 10⁻⁵ risk level.

^d Criteria applies to total trivalent arsenic.

^e Criteria applies to total hexavalent chromium.

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Table 3-6
HISTORICAL OFFSITE SURFACE WATER SAMPLING RESULTS (ppb)
ECC SITE

| Water Quality Parameter ^a | SAMPLE LOCATIONS DOWNSTREAM OF ECC | | | | | | | | | |
|---------------------------------------|------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| | S | | A | | C | | D | | E | |
| | 10/26/82 | 12/14/82 | 03/10/81 | 10/26/82 | 12/14/82 | 03/10/81 | 10/30/81 | 04/10/80 | 03/10/81 | 03/10/81 |
| Aluminum | 480 | 100 | 100 | 300 | 100 | 100 | | | 200 | 12,000 |
| Arsenic | 4 | 2 | 0.7 | 6 | 3 | 1.1 | | | 0.8 | 4.0 |
| Barium | 200 | 200 | | 400 | 100 | | | | | |
| Copper | 12 | 4 | 5 | 9 | 8 | 4 | | | 4 | 17 |
| Iron | 890 | 340 | | 3,600 | 420 | | | | | |
| Lead | 6 | 3 | < 10 | 5 | 5 | 10 | | | 10 | 250 |
| Manganese | 120 | 70 | | 280 | 80 | | | | | |
| Magnesium | | | 116 | | | 116 | | | 100 | 924 |
| Zinc | 10 | 20 | < 10 | 10 | 30 | < 10 | | | < 10 | 60 |
| Strontium | | | 170 | | | 170 | | | 150 | 650 |
| COD | | | 21 | | | 4 | | | 4 | 17 |
| 1,1 Dichloroethene | < 1 | < 1 | < 1 | < 1 | 140 | < 3 | < 5 | ND | < 1 | < 6 |
| 1,1 Dichloroethane | < 1 | < 1 | 1.9 | 220 | < 1 | 26 | 6 | ND | 1.2 | < 1 |
| 1,2 Trans-dichloroethene | < 1 | < 1 | < 20 | 1,000 | 9 | < 20 | < 5 | 45 | < 1 | < 20 |
| Methylene Chloride | < 1 | < 1 | 1.1 | < 1 | < 1 | 18 | 350 | < 10 | 3.5 | < 10 |
| Trichloroethene | < 1 | 2 | 4.4 | 670 | 23 | 33 | 10 | 122 | 1 | < 12 |
| Tetrachloroethene | < 1 | 1 | 1.2 | 37 | < 1 | 2 | 1.8 | < 10 | < 1 | 1.2 |
| Toluene | < 1 | 2 | < 3 | 7 | 2 | 5 | < 6 | < 10 | < 3 | < 3 |
| 1,1,1 Trichloroethane | < 1 | < 1 | 5.9 | 510 | < 1 | 30 | 570 | ND | < 1 | 9.1 |
| Chloroform | < 1 | < 1 | | < 1 | < 1 | | 11.5 | < 10 | | < 6 |
| 1,1,2 Trichloro-1,2,2-trifluoroethane | < 1 | < 1 | < 2 | < 1 | < 1 | < 40 | < 5 | ND | < 10 | 54 |
| Methyl ethyl ketone | | | < 52 | | | 270 | 1,900 | ND | 210 | < 26 |
| 2,4 Dimethylphenol | < 1 | < 1 | | 12 | < 1 | | < 10 | ND | | |
| Phenol | < 1 | < 1 | < 0.2 | 2,200 | < 1 | < 0.2 | < 10 | 14 | < 0.2 | < 0.2 |
| Butyl benzyl phthalate | < 1 | < 1 | | 11 | < 1 | | < 100 | ND | | |
| Bis (2-chloroethyl) ether | < 1 | < 1 | | 43 | < 1 | | < 10 | ND | | |
| 1-2 Dichlorobenzene | < 1 | < 1 | | 57 | < 1 | | < 10 | < 10 | | |
| Diethyl phthalate | < 1 | < 1 | | 6 | < 1 | | < 20 | ND | | |
| Dimethyl phthalate | < 1 | < 1 | | 16 | < 1 | | < 20 | ND | | |
| Di-n-butyl phthalate | < 1 | < 1 | | 27 | < 1 | | < 30 | < 10 | | |
| Bis (2-ethylhexyl)phthalate | < 1 | < 1 | < 0.35 | 13 | < 1 | < 0.35 | < 100 | ND | < 0.35 | < 0.35 |
| Isophorone | < 1 | < 1 | | 360 | < 1 | | | ND | | |
| n-Nitrosodimethylamine | < 1 | < 1 | | 9 | < 1 | | - | ND | | |

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Table 3-6 (continued)

| Water Quality Parameter | SAMPLE LOCATIONS UPSTREAM OF ECC | | | | | EPA Water Quality Criteria ^b |
|--|----------------------------------|---------------|---------------|---------------|----------|---|
| | J 04/10/80 | K 04/10/80 | N 03/10/81 | P 03/10/80 | 10/26/82 | |
| Aluminum | | | 100 | 100 | 80 | -- |
| Arsenic | | | 0.2 | 0.7 | 3 | 0.022 ^{d,e} |
| Barium | | | | | 200 | -- |
| Copper | | | < 4 | < 4 | 9 | NCA |
| Iron | | | | | 530 | -- |
| Lead | | | 10 | < 10 | 6 | 50 ^c |
| Manganese | | | | | 110 | -- |
| Magnesium | | | 200 | 220 | | -- |
| Zinc | | | < 10 | < 10 | 10 | NCA |
| Strontium | | | 90 | 160 | | -- |
| COD | | | 6 | 8 | | -- |
| 1,1-Dichloroethene | ND | ND | < 1 | < 1 | < 1 | 0.33 ^d |
| 1,1-Dichloroethane | ND | ND | < 1 | < 1 | < 1 | NCA |
| 1,2-Trans-dichloroethene | ND | ND | < 1 | < 1 | < 1 | NCA |
| Methylene Chloride | < 10 | < 10 | 1.3 | < 1 | < 1 | 1.9 ^d |
| Trichloroethene | ND | ND | < 1 | < 1 | < 1 | 27 ^d |
| Tetrachloroethene | ND | ND | < 1 | < 1 | 5 | 8 ^d |
| Toluene | ND | ND | < 3 | < 3 | 3 | 14,300 ^c |
| 1,1,1-Trichloroethane | ND | ND | < 1 | < 1 | < 1 | 18,400 ^c |
| Chloroform | < 10 | < 10 | | | < 1 | 1.9 ^d |
| 1,1,2-Trichloro-1,2,2-trifluoromethane | ND | ND | < 2 | < 2 | < 1 | -- |
| Methyl ethyl ketone | ND | ND | < 26 | < 26 | | -- |
| 2,4-Dimethylphenol | ND | ND | | | < 1 | NCA |
| Phenol | ND | ND | < 0.2 | < 0.2 | < 1 | 3,500 ^c |
| Butyl benzyl phthalate | < 10 | ND | | | < 1 | NCA |
| Bis(2-chloroethyl)ether | ND | ND | | | < 1 | 0.3 ^d |
| 1-2-Dichlorobenzene | ND | ND | | | < 1 | 400 ^c |
| Diethyl phthalate | < 10 | < 10 | | | < 1 | 350,000 ^c |
| Dimethyl phthalate | ND | ND | | | < 1 | 313,000 ^c |
| Di-n-butyl phthalate | < 10 | ND | | | < 1 | 34,000 ^c |
| Bis(2-ethylhexyl)phthalate | < 10 | < 10 | < 0.35 | < 0.35 | < 1 | 15,000 ^c |
| Isophorone | ND | ND | | | < 1 | 5,200 ^c |
| n-Nitrosodimethylamine | ND | ND | | | < 1 | -- |

ND = Not Detected

NCA = Insufficient data available upon which to derive a criterion.

Blank indicates parameter not analyzed.

^a Parameters listed are only those that vary substantially from upstream value. See Appendix A for complete results.^b For the protection of human health assuming a daily ingestion of 2 liters of water, 1982.^c Toxicity criteria.^d Carcinogenicity criteria at the 10⁻⁵ risk level.^e Criteria applies to total trivalent arsenic.

A021382

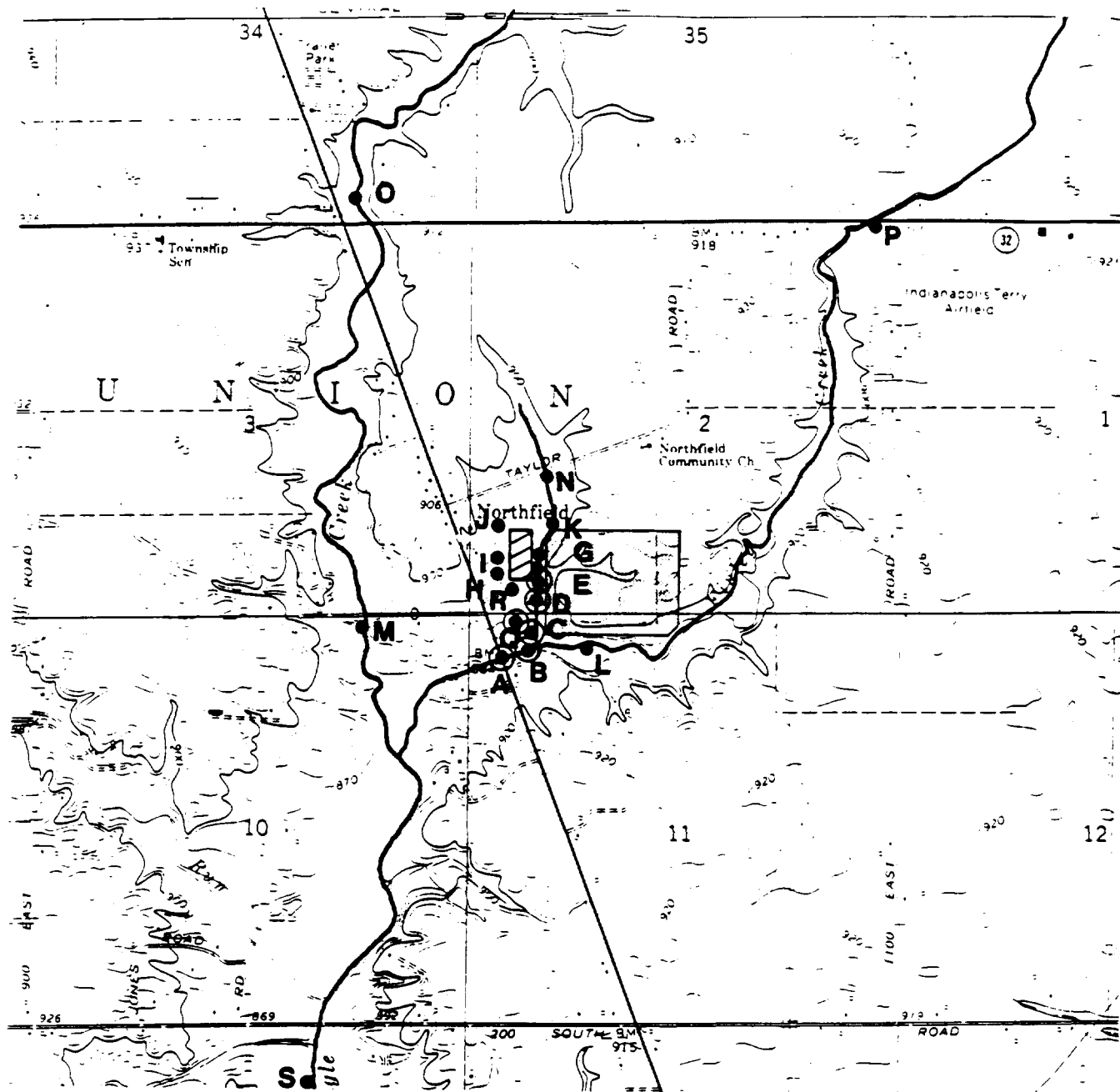


FIGURE 3-4
HISTORICAL SURFACE WATER
SAMPLE LOCATIONS
 ECC RI REPORT

A021383

south of the landfill drive) at 250 ppb. Nickel was reported at 20 ppb at sample locations E (in the unnamed ditch alongside ECC) and K (upstream of ECC in the unnamed ditch).

These inorganic chemicals may be originating from ECC or NSL. Nearly all sample locations downstream of ECC showed at least one inorganic chemical at levels above the upstream values.

Eight organic priority pollutants were detected in surface water downstream of ECC at levels in excess of EPA water quality criteria. These pollutants, were:

- o 1,1 Dichloroethene
- o Methylene chloride
- o Trichloroethene
- o Tetrachloroethene
- o Chloroform
- o Bis (2-chloroethyl)ether
- o Phenol
- o PCB's

These were reported at sample locations A, B, C, D, and E (Figure 3-4).

Analytical results for surface water sediment samples are presented in Table 3-7. As with Table 3-6, this table only presents data for parameters that had as least one reported level greater than upstream values. Six compounds were reported at levels above upstream values: arsenic, chromium, copper, lead, DDD and PCB's.

GROUNDWATER

Sampling and Testing

Sampling and testing of groundwater from monitoring wells at ECC is summarized in Table 3-8. Two monitoring wells were located onsite (Figure 3-5). Sampling has been performed by the ISBH on four occasions and by John Bankert on one occasion. Sampling results from the seven monitoring wells located along the perimeter of NSL are not summarized here.

Documentation of sampling and testing procedures was not found with any of the data. ISBH testing procedures are as described earlier. Testing procedures by O.A. Laboratories, Inc., laboratory for John Bankert, were not researched since only two samples were subjected to limited analyses.

Results

Table 3-7
HISTORICAL OFFSITE SURFACE WATER SEDIMENTS (ppb)
SAMPLING RESULTS
ECC SITE

| Sediment Quality Parameter ^a | SAMPLE LOCATION DOWNSTREAM OF ECC | | | | | | | | | SAMPLE LOCATIONS UPSTREAM OF ECC | | | | |
|---|-----------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------------------------------|----------|----------|----------|----------|
| | S | A | | C | | E | Q | R | N | O | P | | | |
| | 10/26/82 | 08/25/80 | 03/10/81 | 10/26/82 | 08/25/80 | 03/10/81 | 03/10/81 | 03/10/81 | 03/10/81 | 03/10/81 | 08/25/80 | 08/25/80 | 03/10/81 | 10/26/82 |
| Arsenic | < 1,000 | 1,000 | 5,700 | 1,000 | 3,000 | 4,400 | 10,000 | 5,200 | 8,800 | 6,500 | < 1,000 | 2,000 | 6,600 | 1,000 |
| Chromium | 3,000 | 10,000 | 9,000 | 40,000 | 60,000 | 6,000 | 9,000 | 3,000 | 11,000 | 4,000 | 10,000 | 13,000 | 3,000 | 4,000 |
| Copper | 8,000 | 20,000 | 27,000 | 21,000 | 20,000 | 8,000 | 20,000 | 10,000 | 16,000 | 11,000 | 20,000 | 20,000 | 8,000 | 11,000 |
| Lead | 30,000 | 50,000 | 160,000 | 120,000 | 80,000 | 48,000 | 11,000 | 18,000 | 89,000 | 17,000 | 20,000 | 30,000 | 7,000 | 20,000 |
| DDD | 0.5 | < 0.1 | | 3.3 | < 0.1 | | | | | < 0.1 | 0.6 | | | 0.7 |
| PCB's | 5 | 120 | < 1,000 | 72 | 10 | < 1,000 | < 1,000 | < 0.5 | < 1,000 | < 1,000 | 1 | 10 | < 1,000 | 13 |

^a Sediment quality parameters listed are only those that vary substantially from upstream values.

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A021386

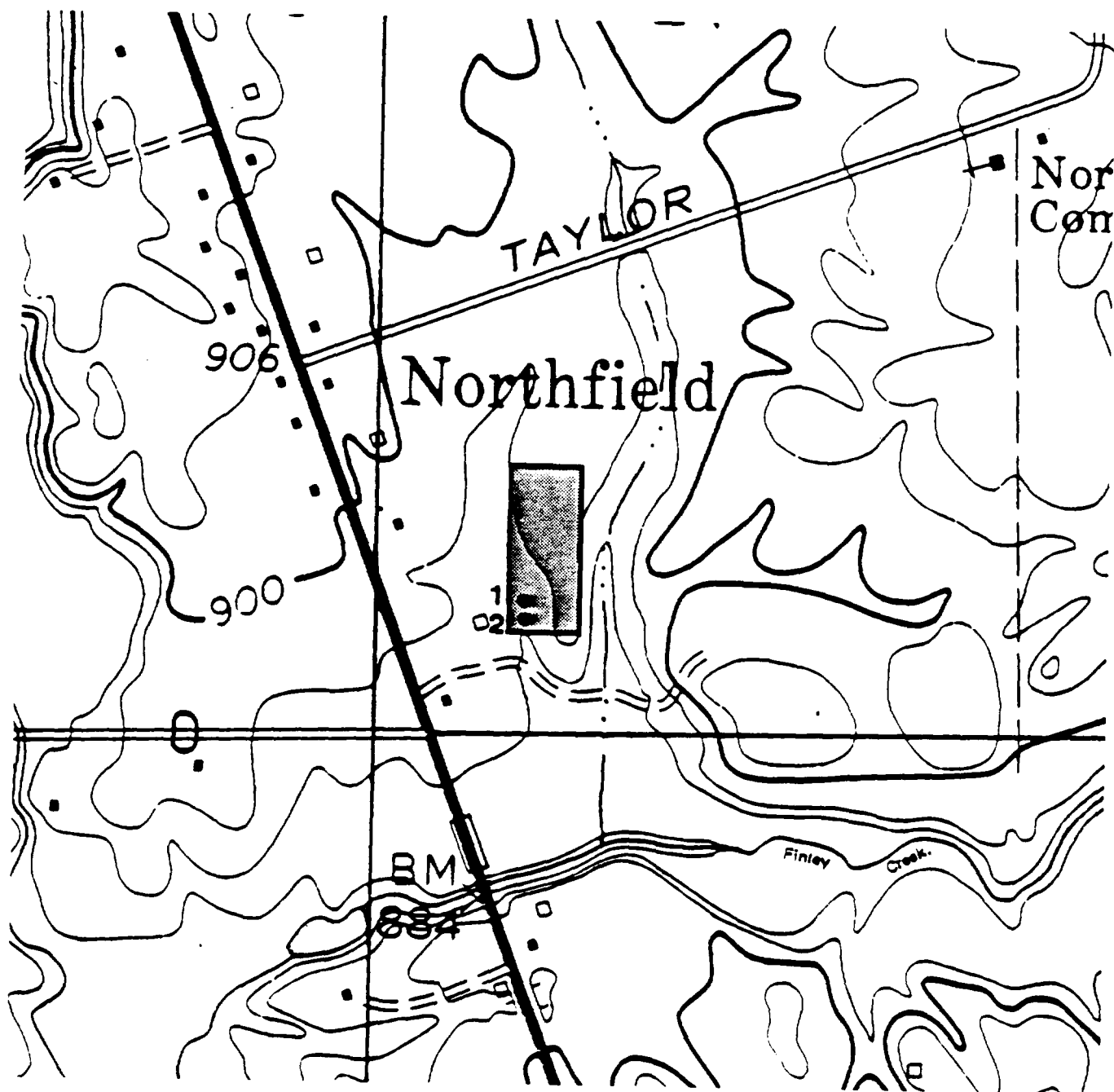
Table 3-8
HISTORICAL GROUNDWATER SAMPLING
ECC SITE

| <u>Sampler</u> | <u>Sampling Date</u> | <u>Analytical Laboratory</u> | <u>Document Number</u> | <u>Monitoring Well Location^a</u> | <u>No. of Samples</u> | <u>Parameters Analyzed</u> | <u>Data Summary</u> |
|----------------|----------------------|---|------------------------|---|-----------------------|---|---------------------|
| John Bankert | 9/15/76 | O.A. Laboratories | 19 | 1, 2 | 2 | pH, COD, Fe, Cr, Cr ⁺⁶ , Ni, Pb, Zn, Cd, Cl ⁻ | Table 3-9 |
| ISBH | 8/14/79 | Water Laboratory, ISBH | 29 | 1, 2 | 2 | Cl ⁻ , Fe, COD, TS, Hardness, Sulfates | None |
| ISBH | 3/17/81 | Water Laboratory, ISBH | 86 | 1, 2 | 2 | Metals, volatile organics, others | Table 3-9 |
| ISBH | 7/2/81 | Water Laboratory, ISBH | 121 | 1, 2 | 2 | Metals, volatile organics, others | Table 3-9 |
| ISBH | 11/29/82 | Water Laboratory, ISBH Hygrid Laboratory | 243 | 2 | 2 | Metals, volatile organics, others | Table 3-9 |

^a Well depths as follows: 1 = 71', 2 = 36'

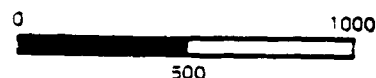
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LEGEND

- APPROXIMATE MONITORING WELL LOCATION



SCALE IN FEET

A021388

**FIGURE 3-5
ECC MONITORING WELL
LOCATIONS (1982)
ECC RI REPORT**

Analytical results are summarized in Table 3-9. Complete organic and inorganic priority pollutant analyses were not performed on any groundwater samples. For the samples tested, no inorganic pollutants were found at levels exceeding EPA water quality criteria. Two of the twelve organic priority pollutants were detected at levels above EPA water quality criteria. These were methylene chloride and trichloroethene. Other organic pollutants reported at levels above the detection limit were: 1, 2 - dichloroethane, 1, 1, dichloroethane, 1, 2 trans-dichloroethene, 1, 1, 1 trichloroethane, methyl ethyl ketone, toluene and isophorone.

RESIDENTIAL WELL WATER

Sampling and Testing

Residential well water sampling and testing activities are summarized in Table 3-10. Four sampling episodes were performed by the ISBH and one by Ira Jennings, a homeowner near ECC. Locations of the residential wells sampled are shown in Figure 3-6.

Documentation of sampling and testing procedures was not found with any of the data. ISBH testing procedures are as described earlier. Sampling of the Ira Jennings well was by Mr. Jennings. The sampling procedures used by him are

Table 3-9
HISTORICAL GROUNDWATER SAMPLING (ppb)
ECC SITE

| Water Quality Parameter | MONITOR WELL 1 | | | MONITOR WELL 2 | | | | | EPA Water Quality Criteria ^a |
|--|----------------|----------|----------|----------------|----------|----------|----------|----------|---|
| | 09/15/76 | 03/17/81 | 07/02/81 | 09/15/76 | 03/17/81 | 07/02/81 | 01/29/82 | 01/29/82 | |
| Aluminum | | < 100 | | | 100 | | | | |
| Arsenic | | 50 | 150 | | 2.6 | 0.2 | 38 | 32 | 0.02 ^{c,d} |
| Barium | | | 130 | | | 50 | | | -- |
| Copper | | < 4 | < 4 | | 18 | < 4 | | | NCA ^{b,e} |
| Chromium | < 100 | < 10 | 15 | < 100 | < 10 | < 10 | | | 50 ^{b,e} |
| Cyanide | | < 5 | | | < 5 | | | | 200 ^b |
| Cadmium | < 100 | < 2 | < 2 | < 100 | < 2 | < 2 | < 2 | < 2 | 10 ^b |
| Iron | 2,600 | | 2,000 | 32,000 | | < 50 | | | -- |
| Lead | < 100 | < 10 | < 10 | < 100 | < 10 | < 10 | < 10 | 10 | 50 ^b |
| Magnesium | | 88,000 | | | 88,000 | | | | -- |
| Nickel | < 100 | < 10 | < 10 | < 100 | < 10 | < 10 | | | 13.4 ^b |
| Strontium | | 1,000 | | | 50 | | | | -- |
| Zinc | 70 | 10 | < 10 | 290 | 790 | < 10 | | | NCA |
| TOC | | | 3,900 | | | 2,100 | 28 | 31 | -- |
| COD | 16,000 | < 5,000 | 26,000 | 125,000 | < 5,000 | 10,000 | 240 | 220 | -- |
| pH (lab) | 8.18 | 7.7 | 8.0 | 8.55 | | 7.6 | 7.1 | 7.1 | -- |
| 1,2-Dichloroethane | | < 1 | < 1 | | < 12 | 2.4 | < 10 | < 100 | 9.4 ^c |
| 1,1 Dichloroethane | | < 1 | < 1 | | 50 | 41 | 160 | 130 | NCA ^c |
| 1,1 Dichloroethene | | | < 1 | | < 1 | < 1 | < 2 | < 1 | 0.33 ^c |
| 1,2 Transdichloroethene | | < 1 | < 1 | | < 1 | < 1 | 580 | 500 | NCA |
| Methylene Chlorine | | < 1 | < 1 | | 5.7 | < 1 | 14 | 32 | 1.9 ^c |
| Trichloroethene | | < 1 | < 1 | | 10 | 58 | 7.6 | < 10 | 27 ^c |
| Tetrachloroethene | | < 1 | < 1 | | < 1 | < 1 | < 10 | < 100 | 8 ^c |
| Trichlorofluoromethane | | < 2 | < 1 | | | | < 10 | < 10 | 1.9 ^c |
| 1,1,1 Trichloroethane | | < 1 | < 1 | | | 1.2 | 30 | < 100 | 18,400 ^b |
| Chloroform | | | < 1 | | | < 1 | < 10 | < 100 | 1.9 ^c |
| 1,1,2 Trichloro-1,2,2-tri-fluoroethane | | < 2 | | | < 2 | | ND | ND | -- |
| bis(2-ethylhexyl)phthalate | | < 350 | | | < 350 | | | | 15,000 ^b |
| Methyl ethyl ketone | | < 25 | < 26 | | < 25 | < 26 | 2,300 | 2,600 | -- |

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Table 3-9 (Continued)

| Water Quality Parameter | MONITOR WELL 1 | | | MONITOR WELL 2 | | | | | EPA Water Quality Criteria ^a |
|-------------------------|----------------|----------|----------|----------------|----------|----------|----------|----------|---|
| | 09/15/76 | 03/17/81 | 07/02/81 | 09/15/76 | 03/17/81 | 07/02/81 | 01/29/82 | 01/29/82 | |
| Phenol | | < 200 | | | < 200 | | | | 3,500 ^b |
| Ethyl benzene | | | < 4 | | | < 4 | 13 | 13 | 1,400 ^b |
| Toluene | | < 4 | < 4 | | < 4 | 5.5 | 13 | 15 | 14,300 ^b |
| Xylene | | < 8 | < 8 | | < 4 | < 8 | < 60 | < 60 | -- |
| Diazanone | | < 0.3 | | | < 0.3 | | | | -- |
| Isophorone | | | | | | | 47 | 110 | 5,200 ^b |
| PCB | | < 0.5 | | | < 0.5 | | | | 0.00079 ^c |

NCA = Insufficient data available upon which to derive a criterion.

Blank indicates parameter not analyzed.

^a For the protection of human health assuming a daily ingestion of 2 liters of water, 1982.

^b Toxicity criteria.

^c Carcinogenicity criteria at the 10^{-5} risk level.

^d Criteria applies to total trivalent arsenic.

^e Criteria applies to total hexavalent chromium.

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A021331

Table 3-10
HISTORICAL RESIDENTIAL WELL WATER SAMPLING
ECC SITE

| <u>Sampler</u> | <u>Sampling Date</u> | <u>Analytical Laboratory</u> | <u>Document Number</u> | <u>Sampling Location</u> | <u>No. of Water Samples</u> | <u>Parameters Analyzed</u> | <u>Data Summary</u> |
|----------------|----------------------|---------------------------------|------------------------|------------------------------|-----------------------------|--|---------------------|
| ISBH | 8/14/79 | Water Laboratory, ISBH | 29 | 2 | 1 | Cl ⁻ , COD, Fe, Hardness, Sulfate | Table 3-11 |
| ISBH | 9/5/80 | Water Laboratory, ISBH | 71 | 3, 7, 9, 10, 13 | 5 | Cd, Cr ⁺⁶ , COD, Cu, Fe, Pb, pH, phenol, TOC Hardness, Cl ⁻ | Table 3-11 |
| ISBH | 3/5/81 | Water Laboratory, ISBH | 83 | 1, 2, 4, 5, 6, 7, 11, 12, 14 | 9 | Metals, PCB, volatile organics, others | Tables 3-11, |
| Ira Jennings | 6/26/82 | Environmental Consultants, Inc. | 241 | 8 | 1 | Metals, methylene chloride, 1,1,2 trichloro- ethane, tetrachloroethene | Table 3-11 |
| ISBH | 12/9/82 | Water Laboratory, ISBH | 242 | 1 | 1 | Volatile organics, others | None ^a |

^a No parameters with values above detection limits.

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A021352



FIGURE 3-6
HISTORICAL RESIDENTIAL WELL
SAMPLING LOCATIONS
ECC RI REPORT

unknown. Analysis of the sample was performed by Environmental Consultants, Inc. Testing and quality control procedures employed by the laboratory were not researched since only one sample was analyzed.

Results

Analytical results are summarized in Tables 3-11 and 3-12. Table 3-11 is a summary of residential well water sampling results for water quality parameters where levels above detection limits were reported. Table 3-12 is a list of additional organic pollutants analyzed by ISBH and not found above detection limits in any wells. Complete organic and inorganic priority pollutant analyses were not performed on any well water samples prior to the onset of Superfund activities at the site.

The sample of the Ira Jennings well was the only sample where a water quality parameter was detected at levels above the EPA water quality criteria. Lead, methylene chloride, 1, 1, 2 trichloroethane and tetrachloroethene were found to be above the EPA water quality criteria.

SOIL

Sampling and Testing

Table 3-11
HISTORICAL RESIDENTIAL WELL WATER SAMPLING RESULTS (ppb)
ECC SITE

| Water Quality Parameter | 1 03/05/81 | 2 08/04/79 | 3 03/05/81 | 4 09/05/80 | 5 03/05/81 | 6 03/05/81 | 7 09/05/80 | 8 03/05/81 | 9 06/26/82 | 10 09/05/80 | 11 03/05/81 |
|-------------------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|----------------|----------------|
| Aluminum | < 100 | | < 100 | | < 100 | < 100 | | < 100 | | | < 100 |
| Arsenic | 0.9 | | 0.8 | | < 0.2 | 0.3 | | 3.1 | 10 | | 0.4 |
| Beryllium | < 10 | | < 10 | | < 10 | < 10 | | < 10 | | | < 10 |
| Cadmium | < 2 | | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 | 9 | < 2 | < 2 |
| Chromium-hex. | < 10 | | < 10 | < 10 | < 10 | < 10 | < 10 | < 10 | | < 10 | < 10 |
| Chromium-tot. | < 10 | | < 10 | | < 10 | < 10 | | < 10 | < 3 | | < 10 |
| Cyanide (free) | < 5 | | < 5 | | < 5 | < 5 | | < 5 | | | < 5 |
| Iron | 960 | 3,100 | 3,000 | 2,850 | 1,000 | 1,100 | 3,050 | 2,600 | | 260 | 2,800 |
| Lead | < 10 | | < 10 | < 20 | < 10 | < 10 | < 20 | < 10 | 93 | < 20 | < 10 |
| Mercury | < 0.1 | | < 0.1 | | < 0.1 | < 0.1 | | < 0.1 | < 0.5 | | < 0.1 |
| Strontium | 500 | | 500 | 700 | 700 | 800 | 500 | | | | 700 |
| Copper | | | | 11 | < 4 | < 4 | < 4 | < 4 | | 26 | < 4 |
| Phenol | | | | < 5 | | | < 5 | | | < 5 | < 5 |
| Barium | | | | | | | | | 403 | | |
| TOC | | | | 5,200 | | | < 1,000 | | | 2,400 | 3,000 |
| COD | | 8,000 | | 14,000 | | | 7,000 | | | 9,000 | 11,000 |
| Hardness (CaCO ₃) | 272,000 | 332,000 | 356,000 | 248,000 | 268,000 | 272,000 | 424,000 | 432,000 | | 224,000 | 288,000 |
| Chlorides | < 5,000 | 7,000 | 10,000 | < 5,000 | < 5,000 | < 5,000 | 16,000 | 15,000 | | 6,000 | 5,000 |
| pH (lab) | 6.9 | | 6.7 | 7.0 | 6.9 | 6.9 | 6.9 | 6.6 | | 7.1 | 7.1 |
| Methylene Chloride | | | | | | | | | 20 | | |
| 1,1,2 trichloroethane | | | | | | | | | 31 | | |
| tetrachloroethene | < 1 | | < 1 | | < 1 | < 1 | | < 1 | 46 | | < 1 |

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A021395

Table 3-11 (Continued)

| Water Quality Parameter | 12 03/05/81 | 13 09/05/80 | 14 03/05/81 | EPA Water Quality Criteria ^a |
|-------------------------------|----------------|----------------|----------------|---|
| Aluminum | < 100 | | < 100 | -- |
| Arsenic | 16 | | 26 | 0.022 ^{c,d} |
| Beryllium | < 10 | | < 10 | 0.68 ^c |
| Cadmium | < 2 | < 2 | < 2 | 10 ^b |
| Chromium-hex. | < 10 | < 10 | < 10 | 50 ^b |
| Chromium-tot. | < 10 | | < 10 | 170,000 ^b |
| Cyanide (free) | < 5 | | < 5 | 200 ^b |
| Iron | 3,900 | 1,030 | 2,300 | -- |
| Lead | < 10 | < 20 | < 10 | 50 ^b |
| Mercury | < 0.1 | | < 0.1 | 0.144 ^b |
| Strontium | 1,000 | | 1,500 | -- |
| Copper | < 4 | < 4 | < 4 | NCA ^b |
| Phenol | | < 5 | | 3,500 ^b |
| Barium | | | | -- |
| TOC | | 5,500 | | -- |
| COD | | 14,000 | | -- |
| Hardness (CaCO ₃) | 300,000 | 188,000 | 258,000 | -- |
| Chlorides | 9,000 | < 5,000 | < 5,000 | -- |
| pH (lab) | 6.9 | 7.3 | 6.9 | -- |
| Methylene Chloride | | | | 1.9 ^c |
| 1,1,2 trichloroethane | | | | 6.0 ^c |
| tetrachloroethene | < 1 | | < 1 | 8.0 ^c |

NCA = Insufficient data available upon which to derive a criterion.

Blank indicates parameter not analyzed.

^a For the protection of human health assuming a daily ingestion of 2 liters of water, 1982.

^b Toxicity criteria.

^c Carcinogenicity criteria at the 10⁻⁵ risk level.

^d Criteria applies to total trivalent arsenic.

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A021396

Table 3-12
RESIDENTIAL WELL WATER SAMPLING ANALYSIS
ORGANICS (ppb)
ISBH SAMPLING 3/5/81^a

| <u>Parameter</u> | <u>Detection Limit</u> |
|-------------------------|----------------------------|
| Pyridine | < 1,000 |
| Cresol | < 200 |
| Heptachlor | < 0.02 |
| Chloridane | < 0.24 |
| Toluene | < 3 |
| MIBK | < 12 |
| Methyl ethyl ketone | < 26 |
| Malathion | < 1.1 |
| O-xylene | < 3 |
| Benzene | < 3 |
| 1,1 dichloroethane | < 1 |
| 1,2 dichloroethene | < 1 |
| trichlorofluoromethane | < 1 |
| dichlorodifluoromethane | ND |
| tetrachloroethene | < 1 |
| trichloroethene | < 1 |
| vinyl chloride | ND |
| strobane | < 1 |
| diazinon | < 0.3 |
| dimethyl phenanthrene | < 500 |
| trimethyl phenanthrene | < 500 |
| PCB arachlor 1016 | < 0.5 |
| PCB arachlor 1242 | < 0.5 |
| PCB arachlor 1254 | < 0.5 |
| PCB arachlor 1260 | < 0.5 |

ND = Not detected.

^a All nine residential well samples were reported to be below the detection limits for the parameters listed above.

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A021397

Sampling and testing of soil at ECC has been limited to one sample obtained by ISBH on March 2, 1979, from the dike between the cooling water pond and the unnamed ditch. Documentation of sampling and testing procedures was not found with the data.

Results

Analysis of the soil sample was limited to four parameters as follows:

- o COD 30,000 ppb
- o Pb < 1,000 ppb
- o Hg 65,000 ppb
- o Phenol 300 ppb

The mercury level greatly exceeds the maximum contaminant limit of 200 ppb for EP toxicity for solid wastes.

AQUATIC BIOTA

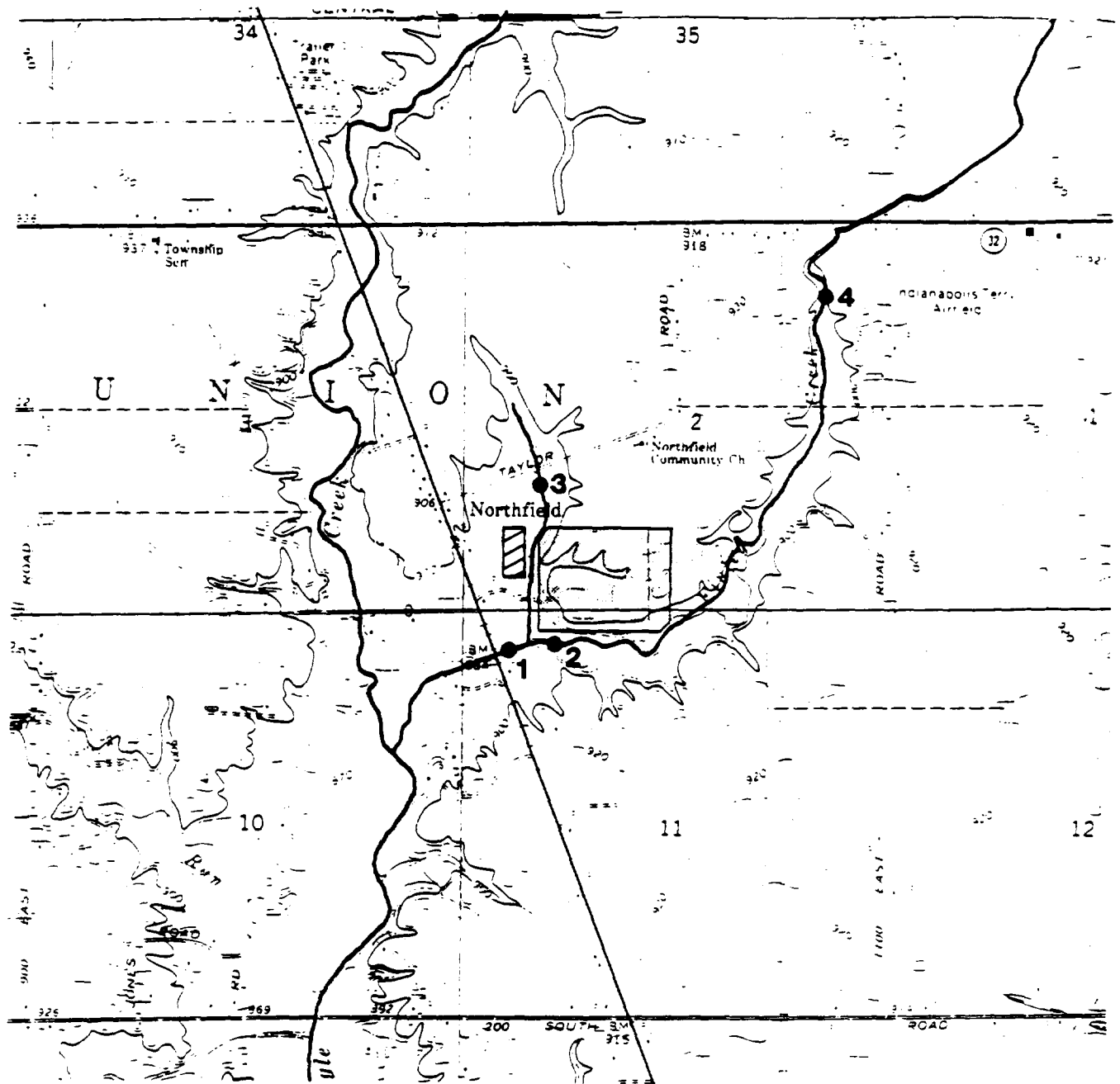
Sampling and Testing

Two studies, a bioaccumulation study on freshwater mussels and a biological assessment of stream ecosystems, have been performed in the vicinity of ECC. In the first study, the ISBH suspended live freshwater mussels, Lampsilis radiata

siluoides) in wire baskets at four locations on April 24, 1981, (Figure 3-7). On June 9, 1981 the mussels were taken out of the streams, wrapped in solvent-rinsed aluminum foil, and kept frozen until analyzed. Each sample consisted of five mussels.

The second study was performed by members of the Department of Zoology, Depauw University, from 1978 to 1980 as part of a larger biological monitoring program. It included assessment of fish populations and benthic macroinvertebrates. One of the watersheds studied was the Eagle Creek watershed, including Finley Creek. Figure 3-8 shows the locations of sample stations. Fish were collected using an electric seine. After being stunned, they were placed in live nets for later identification. Three passes were made in each stream stretch. Benthic macroinvertebrates were collected with a square foot Surber sampler and a long handled dip net. Three replicates were collected at each station with each sampling device. Sampling normally took place once a month in May, June, July, August and October in 1978, 1979 and 1980. More complete sampling method descriptions are available in the report, "The Biological Monitoring Program of the Indiana MIP," by J.R. Gammon, M.D. Johnson, C.E. Mays and D.A. Schiappa.

Results



LEGEND

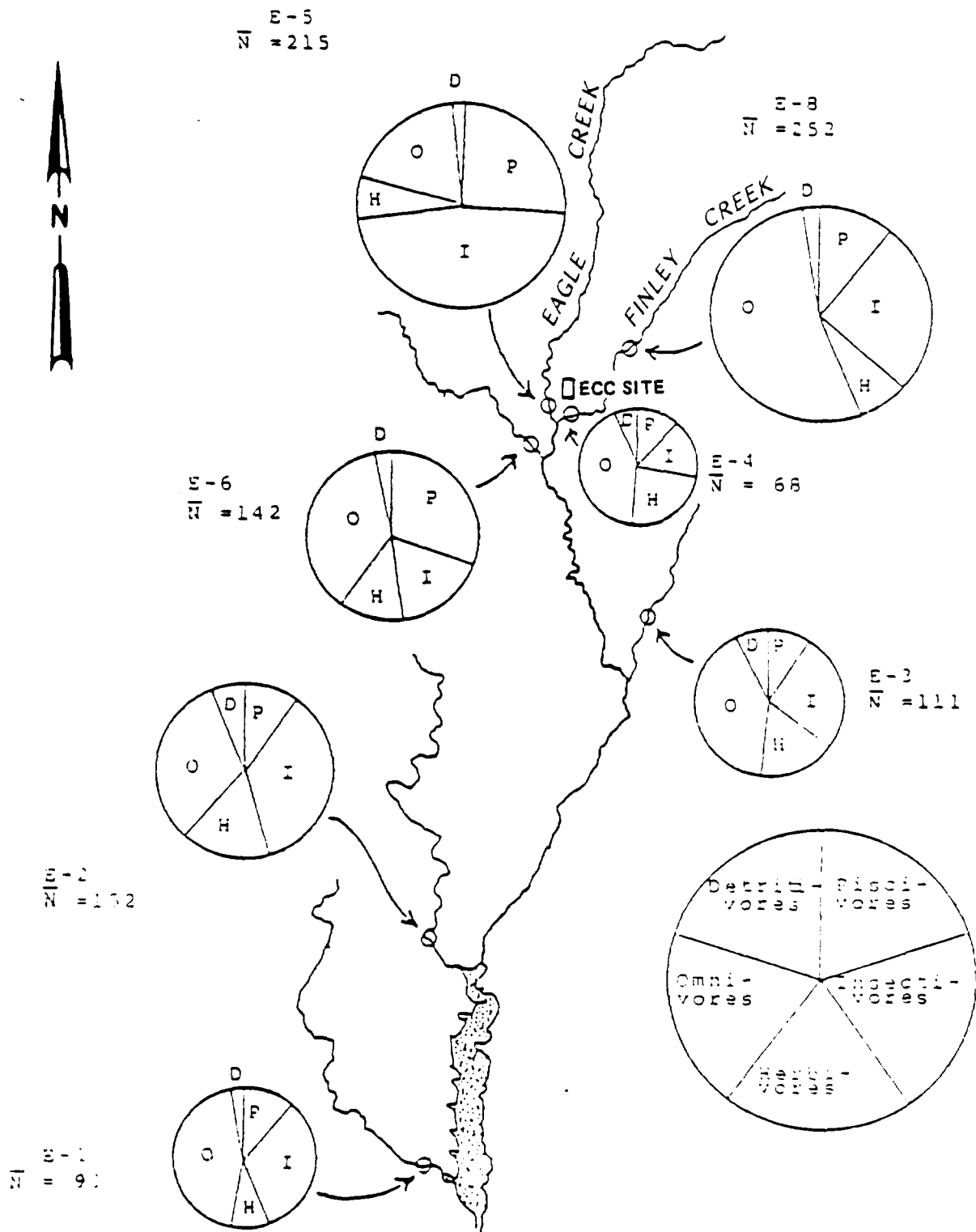
-  NORTHSIDE SANITARY LANDFILL
-  ECC SITE



2000
SCALE IN FEET

A02100

FIGURE 3-7
HISTORICAL BIOACCUMULATION
STUDY SITES
ECC RI REPORT



SOURCE: The Biological Monitoring Program of the Indiana MIP.
J.R. Gammon, M.D. Johnson, C.E. Mays, and D.A. Schiappa.
Department of Zoology, DePauw University.

A021401
FIGURE 3-8
FISH POPULATION
ASSESSMENT (1980)
ECC RI REPORT

Analytical results from the mussel bioaccumulation study are presented in Table 3-13. The only parameter to be reported at levels higher downstream than upstream of ECC was arsenic.

Results of the Biological Monitoring Program assessment of fish population are shown in Figure 3-8. The mean standing crop of fish is much less at downstream station E4, compared to upstream station E8. Data on macroinvertebrates presented in the report is limited to a ranking of sample stations according to density, biomass or number of families (Table 3-14). Station E4 consistently ranked low in each category.

PREVIOUS REMOVAL MEASURES

Chemical Waste Management Inc. (Chem Waste) was hired by the generators to conduct the ECC site cleanup. Chem Waste began onsite activities at ECC on July 11, 1983, and plans to be completed with all of their work by the end of July 1984. Following is a summary of work completed to date:

- o Sampling and fingerprint testing of 29,192 drums.
- o Shipment offsite to a licensed hazardous waste disposal facility of 20,349 drums of waste.

Table 3-13
FRESHWATER MUSSEL
BIOACCUMULATION STUDY (ppb)
ECC SITE

| PARAMETER | SAMPLE LOCATION DOWNSTREAM OF ECC | | SAMPLE LOCATIONS UPSTREAM OF ECC | | | | | | FDA ACTION LEVEL ^b |
|------------|--------------------------------------|-------|----------------------------------|-------|-------|-------|-------|-------|----------------------------------|
| | 1A | 1B | 2A | 2B | 3A | 3B | 4A | 4B | |
| Fat (%) | 51 | 51 | 58 | 60 | 41 | 57 | 87 | 98 | |
| Arsenic | 740 | 750 | 480 | 560 | 540 | 620 | 500 | 580 | |
| Cadmium | 300 | 340 | 260 | 320 | 320 | 300 | 220 | 280 | |
| Chromium | 400 | 400 | < 200 | 600 | 400 | 200 | 300 | 1,000 | |
| Copper | 1,400 | 1,100 | 1,400 | 1,100 | 800 | 1,000 | 800 | 1,200 | |
| Lead | < 800 | < 800 | < 800 | < 800 | < 800 | < 800 | < 800 | < 800 | |
| Mercury | < 30 | < 30 | < 300 | < 200 | < 300 | < 200 | < 300 | < 200 | 1,000 |
| Silver | < 100 | < 100 | < 100 | < 100 | < 100 | < 100 | < 100 | < 100 | |
| Aldrin | ND | ND | ND | ND | ND | ND | ND | ND | |
| Dieldrin | LOST ^a | 7 | 4 | 5 | 1 | 2 | 2 | 5 | 300 |
| Chlordane | LOST ^a | 7 | 5 | 5 | 17 | 18 | 6 | 6 | 300 |
| DDT | ND | ND | ND | ND | ND | ND | ND | ND | |
| Heptachlor | ND | ND | ND | ND | ND | ND | ND | ND | |
| Diazinon | ND | ND | ND | ND | ND | ND | ND | ND | |
| Strobane | ND | ND | ND | ND | ND | ND | ND | ND | |
| Malathion | ND | ND | ND | ND | ND | ND | ND | ND | |
| PCB's | ND | ND | ND | ND | ND | ND | ND | ND | |

^a Sample Lost

^b Federal Food and Drug Administration Action Level for substances in fish and shellfish

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A021403

Table 3-14
MACROINVERTEBRATES
ECC SITE

RANK OF EAGLE CREEK STREAMS^a

| <u>Stream Mean Pool Depth</u> | <u>Fish (Composite Index)</u> | <u>Bivalvia (Density)</u> | <u>Tipulidae (Biomass)</u> | <u>Ephemeroptera (# of Families)</u> | <u>Baetidae (Density)</u> |
|---------------------------------------|-----------------------------------|-------------------------------|--------------------------------|--|-------------------------------|
| 1. Mounts Run - E6 | 1. E5 | 1. E5 | 1. E5 | 1. E5 | 1. E5 |
| 2. Eagle (upper) - E5 | 2. E6 | 2. E2 | 2. E3 | 2. E6 | 2. E6 |
| 3. Fishback - E2 | 3. E2 | 3. E3 | 3. E2 | 3. E7 | 3. E7 |
| 4. Eagle (lower) - E7 ^b | 4. E3 | 4. E7 | 4. E6 | 4. E2 | 4. E2 |
| 5. Little Eagle - E3 | 5. E1 | 5. E6 | 5. E7 | 5. E3 | 5. E3 |
| 6. Finley - E4 | 6. E4 | 6. E4 | 6. E1 | 6. E4 | 6. E4 |
| 7. School Branch - E1 | 7. | 7. E1 | 7. E4 | 7. E1 | 7. E1 |

^a Invertebrates from Surber only.

^b No fish samples taken.

Source:

The Biological Monitoring Program of the Indiana MIP. J.R. Gammon, M.D. Johnson,
C.E. Mays and D.A. Schiappa. Department of Zoology, Depauw University.

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A021404

- o Crushing onsite and shipment offsite to a licensed hazardous waste disposal facility of 9,558 empty drums.
- o Removal and shipment offsite to licensed disposal facilities of 219,940 gallons of bulk liquid hazardous wastes (primarily flammable solvents).
- o Excavation and shipment offsite to licensed disposal facilities of about 5,200 yd³ of contaminated soil and cooling water pond sludge.
- o Removal and shipment offsite to a licensed hazardous waste treatment facility of about 4,000,000 gallons of contaminated cooling water pond water.
- o Excavation and shipment offsite to a licensed disposal facility of 452 yd³ of contaminated soils from the polymer solidification pit.
- o Pressure washing of the concrete pad (about 27,000 ft²).
- o Cleaning of the processing building and equipment.

Remaining on the ECC site are the empty bulk tanks, the processing building with equipment, the concrete pad, and additional areas of contaminated soils.

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Chapter 4

ANALYSIS OF SITE INVESTIGATIONS

SOIL

SITE GEOLOGY

Boone County, Indiana, is in a physiographic unit known as the Tipton Till Plain, a nearly flat to gently rolling glacial plain, which is the result of continental ice sheets that covered the county about 20,000 years ago. During the period, known as the Pleistocene Epoch, large quantities of earth materials were deposited upon the bedrock surface, with a maximum thickness approaching 350 feet. The major aquifers in Boone County are in sand and gravel deposits of glacial origin. These deposits are also important sources of aggregate materials.

The bedrock formations beneath the glacial drift in Boone County consist of limestones and dolomites of Silurian and Devonian age and shales of Devonian and Mississippian age. The beds generally dip about 10 to 30 feet per mile to the southwest toward the Illinois Basin. In general, the Silurian and Devonian age formations produce small to moderate amounts of water, while the Devonian and Mississippian age shales are not usually good water producers.

Twelve monitoring wells were installed at seven locations around the ECC site (Figure 4-1). Shallow and deep wells were installed in the boreholes at the ECC-1, 3 and 4 cluster locations. Deep, shallow and intermediate wells were installed at the ECC-2 cluster location and single shallow wells were installed at ECC-5, 6, and 7. Well construction drawings are presented in Appendix A.

Laboratory testing included index tests for soil identification and classification. These consisted of Atterberg limits, moisture contents and mechanical grain size analysis. Samples were selected for testing after visual classification of all samples from a borehole and were selected on the basis of being representative of soil types encountered. Laboratory test results are presented in Appendix A.

Mechanical grain size analysis is useful for determining the characteristics of coarse grained soils from a single borehole and for correlating stratigraphic units with similar grain size distributions from several boreholes. Grain size distributions of relatively well sorted and rounded sands and gravels can also be used to estimate soil hydraulic conductivities. Atterberg limits and moisture contents are conducted to determine the plasticity characteristics of silts and clays. This information is useful for cross borehole correlation and for making rough

AO21403



LEGEND

- REMEDIAL INVESTIGATION MONITORING WELL
INSTALLED JUNE AND SEPTEMBER 1983.

x—x ECC BOUNDARY FENCE

NOTE: All well locations are approximate

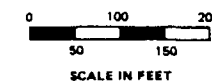


FIGURE 4-1
MONITORING WELL LOCATIONS
ECC RI REPORT

estimates of soil hydraulic conductivity without performing much more costly field and laboratory tests.

Soil types encountered from the ground surface to the top of rock are illustrated in Figure 4-2. These consist of glacial tills, glacial outwash and possibly some shallow alluvial deposits. The glacial till deposits, consisting predominantly of clayey silt and silty clay, formed the thickest sequence encountered. They appear to be highly overconsolidated based on Atterberg limits and relatively impermeable. Glacial outwash sands and gravels were found at all five boring locations. These consisted of fine to coarse sand and gravel that are highly permeable. Some alluvial deposits may occur near the ground surface, especially near the southeast corner of the ECC site and generally consist of fine sand and silty sand. A projection of shallow borings at the ECC site is shown in Figure 4-3. Included are some of the borings completed previously at NSL. The shallow soil stratigraphy appears to be very complex near the south end of the ECC site. This is probably due to the combination of till, outwash and alluvial deposits present in this area.

Three water-bearing zones occur at different elevations and appear to be fairly continuous under the site. These are:

- o A silt sand zone, approximately 5 to 15 feet

AO21411

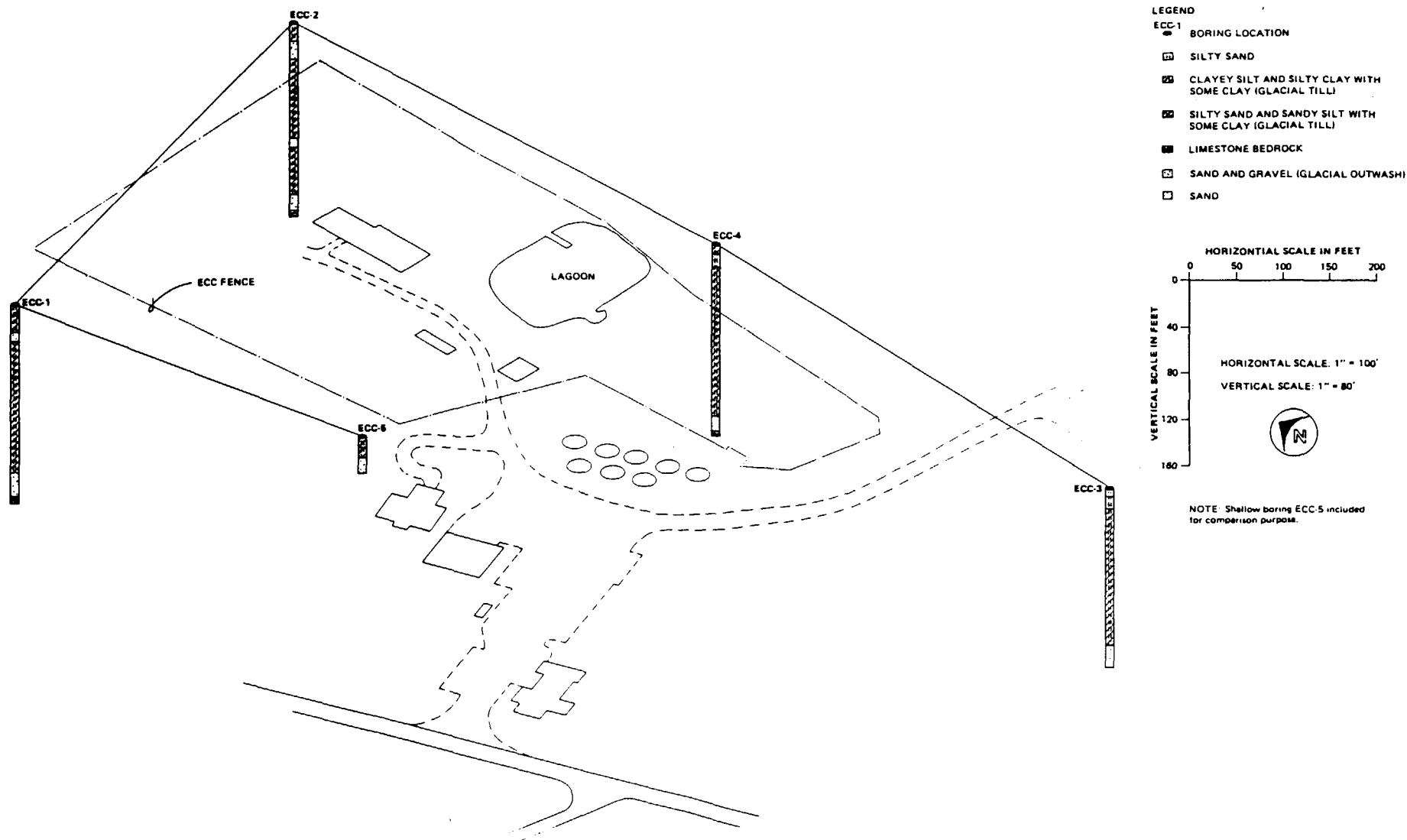
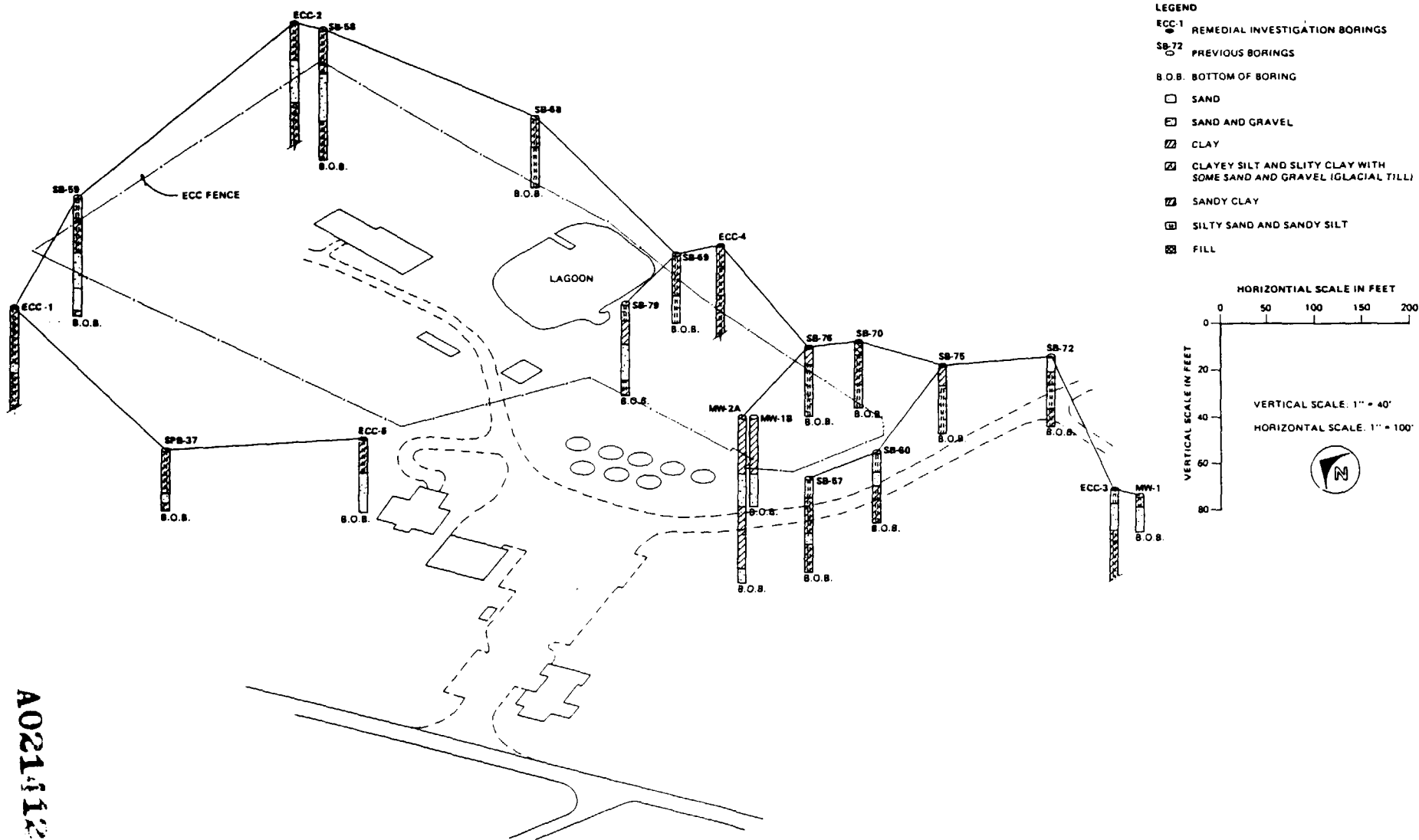


FIGURE 4-2
ISOMETRIC PROJECTIONS
OF DEEP BORINGS
ECC RI REPORT



AO21412

site. Elevated concentrations of iron, aluminum, and manganese were observed in samples collected in close proximity to the ECC and NSL sites. The highest concentrations were observed at location SW-002. Mercury was also detected in notable concentrations at sampling sites SW-003 and 004. The fact that the blank sample contained elevated mercury concentrations introduces the possibility of sample contamination through laboratory or field sampling procedures. Therefore, the presence of mercury in the surface water cannot be attributed to contamination from the site. Nonetheless, even though the concentrations of these elements exceeded their respective drinking water criteria, the level and type of contamination does not represent an environmental hazard. As mentioned earlier, the criteria used for comparison were established for drinking water. Therefore, they are restrictive for surface waters and were used only as a stringent screen for data evaluation.

Sediment concentrations of aluminum, copper, iron, manganese, nickel, and zinc were all higher in samples collected near the ECC and NSL sites than in samples collected upstream or far downstream. With the exception of mercury, sediment concentrations of the remaining inorganic constituents listed in Table 4-7 seem to represent background concentrations or the presence of trace quantities. Mercury, however, was detected at a

concentration of 1.18 milligrams per kilogram at sample location SD-003. Mercury is generally insoluble in water (which would account for the low concentration in the surface water samples taken at the same location) and may, therefore, be accumulating in the sediment after entering the creek in runoff water. High concentrations of mercury in the sediment may pose a potential threat to freshwater aquatic life.

Organic contamination of surface water was limited to location SW-004. Six priority pollutants were identified at concentrations exceeding quantification limits. All six compounds were two-carbon chlorinated hydrocarbons. The six compounds were chloroethane, 1,1-dichloroethane, 1,1,1-trichloroethane, vinyl chloride, trans-1,2-dichloroethene and trichloroethene. Only trichloroethene exceeded the established criterion. Although the available water quality criteria (if any) for the remaining compounds were not exceeded, the presence of even trace amounts of chlorinated hydrocarbons may indicate contamination. The six compounds exhibit mild to moderate toxicity upon ingestion and are mild to strong irritants of the skin and mucous membranes. Most of these compounds are known or suspected animal or human carcinogens. Limited available data suggest these compounds are harmful to aquatic life at moderate to high concentrations. However,

they are generally highly mobile, volatilize readily, and usually are not persistent in the aquatic environment.

ECC site records and chemical analysis data implicate the ECC site as the source of contaminants identified at location SW-004. ECC site records report that chlorinated hydrocarbon solvents were processed at the facility. Further, drainage patterns direct overload flow from the vicinity of the ECC and NSL site towards sampling location SW-004. Sampling location SW-003 is approximately 750 feet upstream of location SW-004 on Finley Creek but receives runoff only from the NSL site. Surface water from this sampling location was found to be uncontaminated by chlorinated hydrocarbons.

Three additional compounds (methylene chloride, o-xylene, and tetrachloroethane) were detected in surface water samples; however, concentrations were below quantifiable limits except in one case. Contamination of samples by these compounds is probably due to field contamination through sampling techniques, inadequate rinsing of decontamination fluids, sample bottle contamination, or lab contamination of the samples. Bis (2-ethylhexyl) phthalate was also detected, but only in concentrations below the quantifiable limit.

Five tentatively identified organic compounds appear in Table 4-11. As can be seen in the table, two compounds are well below the permissible limits suggested by EPA based on health effects. Of the remaining three, only one compound was confirmed in the duplicate sample.

Table 4-9 identifies several semivolatile organic compounds detected in sediment samples. The threat posed to human health from the presence of these compounds is inconclusive since adequate data not available for an accurate evaluation.

GENERAL CONCLUSIONS AND OBSERVATIONS

From the analysis of these results, the following conclusions are drawn:

- o Surface water escaping the ECC site will be directed towards the unnamed tributary of Finley Creek or towards Finley Creek.
- o Elevated concentrations of iron, aluminum, and manganese were observed in surface water samples collected in close proximity to the ECC and NSL sites. Contamination by those compounds does not represent an environmental hazard.

- o Organic contamination of surface water is limited to location SW-004. Contaminants consist almost entirely of chlorinated hydrocarbons.
- o Trichloroethene is the only surface water contaminant to exceed the Water Quality Criteria. For several detected contaminants, applicable criteria do not exist.
- o The presence of chlorinated hydrocarbons at location SW-004 may raise human health and environmental concerns. ECC site records and chemical analysis data implicate the ECC site as the source of organic contaminants detected in location SW-004.
- o With the exceptions of aluminum, copper, iron, nickel, and mercury, observed concentrations of the elements in sediment samples seem to represent background concentrations.
- o Sediment concentrations of aluminum, copper, iron, manganese, nickel, and zinc were higher in samples collected near the ECC and NSL sites than in samples collected upstream or far downstream.

- o Mercury was detected in an elevated concentration in a single sediment sample (SD-003).
- o Organic chemical analysis data for sediments are inconclusive.

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Chapter 5

DEVELOPMENT OF APPLICABLE REMEDIAL ALTERNATIVES

This chapter presents the development of applicable remedial alternatives to address defined problems at the ECC site. Detailed supporting data, evaluations, and observations were presented in the previous chapter, Analysis of Site Investigations.

This chapter is organized into five sections. Problems and pathways of contamination are summarized based on conclusions of the RI analysis (Chapter 4). Remedial goals and objectives are established consistent with the NCP. The identification, selection, and assembly processes for applicable remedial alternatives are discussed. Sets of applicable remedial alternatives that will initially be carried forward into the feasibility study are discussed. The final section is a summary of conclusions drawn from the site investigation analysis presented in the previous chapter.

PROBLEMS AND PATHWAYS OF CONTAMINATION

The problems at the ECC site were identified using a receptor-oriented approach. Consistent with the

NCP[300.68(c)], problems are identified according to the threat to the public health, welfare, and the environment.

Problems and pathways of contamination are arranged according to operable units. They are summarized in Table 5-1 and are discussed briefly in the following sections.

SOIL

The soil contamination problem has resulted from dumped or spilled chemical compounds on several areas of the site. The pathways of contamination are air transport of volatiles and particulates and leaching of compounds into groundwater. Surface water runoff is also a potential pathway. However, considering the current topography at the site, significant flooding and runoff would be required for surface water transport of contaminated soil to offsite areas. Direct contact and carryover by site intruders (human and animal) is not considered a pathway since the site is located in a rural area on private property and is fenced.

GROUNDWATER

Groundwater contamination is primarily caused by volatile organic compounds (VOC's), particularly chlorinated hydrocarbons. Because VOC's are the most widespread of the

Table 5-1
SUMMARY OF ECC PROBLEMS AND PATHWAYS OF CONTAMINATION

| Operable Unit | Problem | Pathway of Contamination (Receptor) |
|-----------------------------|--|--|
| Soil | Surface contamination | Direct skin contact (site intruders) Indirect contact by carryover (site intruders and their contacts) Leachate to saturated/unsaturated zone (groundwater consumer) Transmission by surface water runoff (receiving water local receptors) |
| | Subsurface contamination | Leachate to saturated/unsaturated water runoff (receiving water local receptors) |
| | Volatile organic vapor air contamination | Inhalation of vapors (local receptors) |
| | Contaminated dust from site | Inhalation of airborne dust (local receptors) |
| Groundwater | Contamination with volatile organic compounds and movement of contaminated groundwater offsite | Natural movement of groundwater (potential future consumers/receiving waters) Production well discharges (potential future consumers/receiving waters) |
| Surface Water/ Sediments | Sediment and surface water contamination and movement of contaminants downstream | Direct contact (people/animals) Leaching to surface water (receiving water) Indirect ingestion (fish consumers) Food chain bioaccumulation (biota) |

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A021121

organic contaminants, the VOC's serve as indicators of the extent of the organic contamination of the groundwater system. Presently, there is no known direct contact with contaminated groundwater by groundwater consumers. VOC contamination was not detected in local private wells; however, potential future receptors of contaminated groundwater are considered in identification of the problem. The potential for direct exposure of the greatest number of people is the potential of future VOC contamination of the City of Indianapolis water reservoir (Eagle Creek Reservoir), which is approximately 10 miles south of the site.

A number of organic compounds were identified in the groundwater offsite. It is possible that these compounds could be from NSL rather than the site.

Two pathways of contamination are considered. First, groundwater withdrawal for potable usage; second, groundwater movement to existing or future points of groundwater use or discharge, such as the unnamed ditch or Finley Creek, caused by hydraulic and concentration gradients.

SURFACE WATER/SEDIMENTS

Water, sediments, and fish from Finley Creek and the unnamed ditch were exposed to contaminants during site operation by discharges from the site. Based on the RI data, however, sediment contamination is the only site-related problem concerning the creek and ditch. Pathways of contamination are limited to direct contact by humans or animals. Pathways such as direct contact and ingestion of water game fish are not supported by current data. There is a indication of negative impacts on macroinvertebrates downstream of ECC, but the causes are clearly identifiable.

REMEDIAL GOALS AND OBJECTIVES

The general goal and objective of every remedial action is to "....mitigate(s) and minimize damage to and provide(s) adequate protection of public health, welfare, and the environment...." as specified in 40 CFR300.68(j).

Specifically, the following are remedial goals for the ECC site:

- o Adequately protect against contact with contaminated soil.
- o Minimize damage to and provide adequate protection of the saturated zone from migrating soil contaminants.

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- o Minimize damage from and adequately protect against the spread of contaminated groundwater.
- o Adequately protect against contact and ingestion or future contact and ingestion of contaminated groundwater.
- o Adequately protect against volatile organic and dust emissions into the air.
- o Adequately protect against contact with contaminated creek and ditch sediment.
- o Adequately protect against future contamination of Finley and Eagle Creeks.

Each remedial goal is stated in terms of actions, including no action, that can be accomplished and not in terms of absolute removal, or restoration to pristine conditions. Instead, the goals reflect the NCP objectives to "mitigate and minimize damage" and "provide(s) adequate protection."

CONCEPTUAL REMEDIAL ALTERNATIVES

Conceptual remedial alternatives in addition to the "no action" alternative were identified for each of the operable

units. These conceptual alternatives are summarized in Table 5-2 and discussed briefly below.

SOIL

The conceptual remedies for the problem of soil contamination address the pathways of direct contact and air transport. Containment separates contamination from direct contact with receptors and eliminates transport of contaminants by air and percolating water. Removal and disposal accomplishes the same functions.

GROUNDWATER

Several conceptual remedial actions that provide adequate protection of the public against the contaminated groundwater were identified. Containment, pumping, diversion, and treatment are all reasonable actions. Further screening during the feasibility study will be necessary to reduce the number of potential remedial alternatives to a manageable number.

SURFACE WATER/SEDIMENTS

Problems in the unnamed ditch and Finley Creek are indicated for sediments only. Elimination of stormwater discharge from the site would remedy the obvious source of continuing

Table 5-2
SUMMARY OF SELECTED CONCEPTUAL REMEDIAL ALTERNATIVES

| <u>Operable Unit</u> | <u>Problem</u> | <u>Conceptual Remedial Alternatives</u> |
|-------------------------|---|---|
| Soil | Surface and air contamination Subsurface contamination Air contamination | Capping Containment Removal/disposal No action |
| Groundwater | Contamination with organic compounds and movement of contaminated groundwater offsite | Capping Containment Pumping Onsite treatment/discharge Offsite treatment/discharge Direct Discharge No action |
| Surface Water/Sediments | Sediment contamination | Sediment removal/disposal No action |
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or future contamination of surface waters. Although it does not appear to be a problem now, the discharge of contaminated groundwater to the unmaned ditch or to Finley Creek must be considered. For now, sediment removal is the only conceptual alternative applied to them.

APPLICABLE REMEDIAL TECHNOLOGIES

Table 5-3 provides a summary of the applicable remedial technologies selected to refine each conceptual alternative.

TECHNICAL SELECTION CRITERIA

The criteria for selection or rejection of applicable remedial technologies are based on the following factors:

- o Data on physical site conditions that preclude, restrict, or promote the use of a specific technology
- o. Chemical and physical characteristics of contamination that affect the effectiveness of a remedial technology
- o Inherent nature of a technology such as performance record, reliability, and operating problems

Table 5-3
SUMMARY OF APPLICABLE REMEDIAL TECHNOLOGIES

| <u>Operable Unit</u> | <u>Conceptual Alternative</u> | <u>Applicable Remedial Technologies</u> |
|----------------------|--|--|
| Soil | Capping | Sprayed asphalt membrane Concrete (bituminous or Portland cement) Multilayered systems Gravel over clay Soil over clay Soil over synthetic membrane Soil over clay over synthetic membrane |
| | Containment | Soil & bentonite slurry wall Cement & bentonite slurry wall Vibrating beam asphalt wall Grout curtain |
| | Complete or partial soil removal with disposal | Backhoe/loader/dragline Landfill |
| | Soil Treatment | Soil Washing |
| | No action | - |
| Groundwater | Capping | Sprayed asphalt membrane Concrete (bituminous or Portland cement) Multilayered systems Gravel over clay Soil over clay Soil over synthetic membrane Soil over clay over synthetic membrane |
| | Containment (Vertical barriers downgradient, upgradient, or circumferential) | Soil & bentonite slurry wall Cement & bentonite slurry wall Vibrating beam asphalt wall Grout curtain |
| | Pumping | Drilled wells Extraction Extraction/injection |
| | Onsite treatment/discharge (private treatment facility) | Air stripping Steam stripping Carbon adsorption |

Table 5-3 (continued)

| <u>Operable Unit</u> | <u>Conceptual Alternative</u> | <u>Applicable Remedial Technologies</u> |
|-----------------------------|---------------------------------------|--|
| | Offsite treatment/discharge (POTW) | Air stripping Biological adsorption/degradation Carbon adsorption (PACT) |
| | Direct discharge | Direct outfall Deep well injection |
| | No action | - |
| Surface Water/ Sediments | Sediment removal with disposal | Hydraulic dredging Landfill |
| | No action | - |

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Construction and O&M costs are not criteria for selection of applicable remedial technologies. These costs will be considered along with other criteria during the feasibility study.

APPLICABLE REMEDIAL TECHNOLOGY SELECTION

Based on engineering judgment, several remedial technologies appear to address site problems adequately. For example, seven different techniques and materials are applicable for construction of a site cap, and four options are applicable for vertical barriers. Because so many technologies survived this selection process, the individual applicable technologies will require further screening using additional criteria such as cost in the future feasibility study.

REJECTED REMEDIAL TECHNOLOGIES

During the selection of applicable remedial technologies, several technologies and technology options were rejected. The rejected technologies are summarized in Table 5-4 with explanations for rejection.

REMEDIAL ALTERNATIVE ASSEMBLY

GENERAL REMEDIAL ACTIONS AND TECHNOLOGY OPTIONS

The final step in the development of applicable remedial alternatives is the assembly of alternatives using the selected applicable remedial technologies.

The selected technologies and all possible combinations are too numerous to discriminate reasonably between applicable remedial alternatives. For example, the combination of cap and vertical barrier technologies alone results in 28 alternatives. Therefore, the applicable remedial alternatives will be assembled from general remedial actions and general technology options summarized in Table 5-3. The specific remedial technologies, e.g., types of capping or vertical barriers, will be assessed separately in the next step of the decisionmaking process, the feasibility study.

Nine general remedial actions and technology options were selected to assemble remedial alternatives for further screening:

- o Capping (including grading and revegetation as required)
- o Soil washing
- o Soil removal
- o Downgradient vertical barriers

- o Circumferential vertical barriers
- o Upgradient vertical barriers
- o Extraction well pumping
- o Partial sediment removal
- o No action

These general remedial actions address the site problems listed in Table 5-1. Individually, they address one or more problems but not every problem as shown in Figure 5-1. Therefore, these general remedial actions must be used in appropriate combinations to be assembled into a reasonable number of remedial alternatives.

In addition to the general remedial actions and technology options listed above, contaminant treatment and disposal (applicable to soil, groundwater, and sediment) are also identified in Table 5-3. Treatment and disposal alternatives are considered secondary alternatives because their requirement depends entirely on the primary remedial actions. For example, groundwater treatment and disposal is required only if an extraction pumping alternative is selected. These secondary remedial alternatives will be screened during the feasibility study.

| Identified Site Problems | Primary Remedial Actions and Technology Options | | | | | | | | | |
|-----------------------------------|---|--------------|--------------------------------|-----------------------------------|-------------------------|-----------------------------------|-----------------|------------|----------------------|------------------|
| | Capping | Soil Removal | Downgradient Vertical Barriers | Circumferential Vertical Barriers | Extraction Well Pumping | Extraction/Injection Well Pumping | Decontamination | Demolition | Complete Abandonment | Sediment Removal |
| <u>SOIL</u> | | | | | | | | | | |
| 1. Surface air contamination | X | X | | | | | | | | |
| 2. Subsurface contamination | | X | | | | | | | | |
| <u>GROUNDWATER</u> | | | | | | | | | | |
| 1. VOC contamination and movement | X | X | X | X | X | X | | | | |
| <u>ONSITE FACILITIES</u> | | | | | | | | | | |
| 1. Building contamination | | | | | | | X | X | X | |
| 2. Air contamination | | | | | | | X | X | X | |
| <u>SURFACE WATER/SEDIMENT</u> | | | | | | | | | | |
| 1. Sediment contamination | | | | | | | | | | |

FIGURE 5-1
APPLICATION OF GENERAL
REMEDIAL ACTIONS
ECC RI REPORT

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ASSEMBLED APPLICABLE REMEDIAL ALTERNATIVES

The potential number of assembled remedial alternatives is extremely large and unmanageable when appropriate combinations of the previously listed 9 general remedial actions are considered. The task of assembling remedial alternatives is further complicated by the large number of applicable technologies.

Because of the large number of potential assembled remedial alternatives, assembly of remedial alternatives will be performed during the feasibility study. In the feasibility study, technologies will be assessed and a reasonable number of remedial alternatives assembled.

SUMMARY OF CONCLUSIONS FROM ANALYSIS OF SITE INVESTIGATIONS

- o Contamination of soil by inorganic and organic constituents appears greatest, in both frequency and concentration, in surface or near surface soil (approximately the upper 10 feet).
- o Nearly, all areas sampled within the fenced perimeter of the site indicated soil contamination by organic compounds.

- o The distribution of surface soil contamination by inorganic constituents appears erratic, possibly because of isolated contamination events.
- o Primary organic soil contaminants include pesticides, base/neutral compounds, and volatile organic compounds.
- o Mobilities of organic and inorganic contaminants are uncertain because of complex and unknown interactions among factors affecting mobility, such as organic and inorganic constituents present, concentrations of soil constituents, percent soil organic matter, percent clay, and microbial activity.
- o Groundwater flow directions are across the site and downward toward the south and southeast. The direction of movement of the contaminated groundwater indicates eastward and southward flow beneath the site . However, the lack of sampling points in the in the middle of and southwest of the site does not allow the southwesterly flow path to be evaluated in detail.
- o Groundwater contamination is best defined by the extent of VOC's, many of which are relatively

mobile and persistent. The VOC contamination appears to be in the near surface water table.

- o Direct contamination of surface water as it passes the site is not demonstrated by the data.
- o Contaminated sediments are present in the unnamed ditch.
- o The source of the groundwater and sediment contamination cannot be attributed solely to ECC or NSL without additional investigation.

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Appendix A
PROJECT TECHNICAL MEMORANDUMS

This appendix contains the various technical memorandums prepared for the ECC RI activities.

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Appendix B
HAZARDOUS SUBSTANCE CHARACTERIZATION

This appendix summarizes literature data regarding each of the hazardous substances recorded as being present in the ECC environment at concentrations above background. For each chemical, the summary includes:

- EPA Hazardous Waste Number (EPA HWN)
- Synonyms
- Sources
- Environmental Fate
- Hazard Description

The information is not uniformly complete for all chemicals listed since many of the substances have not yet been thoroughly researched in existing literature.

Table B-1 is a complete list of the substances addressed in this Appendix. Table B-2 lists the references investigated to compile these summaries. Table B-3, B-4, and B-5 are glossaries explaining the terms and abbreviations used in this summary.

Table B-1
LIST OF HAZARDOUS COMPOUNDS

INORGANIC COMPOUNDS

Antimony
Arsenic
Barium
Cadmium
Chromium
Copper
Cyanide
Lead
Manganese
Mercury
Nickel
Silver
Selenium
Zinc

ORGANIC COMPOUNDS

Dichloromethane
Trichloromethane
Trichlorofluoromethane
Chloroethane
1,1-Dichloroethane
1,1,1-Trichloroethane
Chloroethene
1,1-Dichloroethene
trans-1,2-Dichloroethene
Trichloroethene
Tetrachloroethene
Benzene
Toluene
Diethyl phthalate
Chrysene
Fluoranthene
Acetone
2-Butanone
Isophorone
o-Xylene
Styrene
Pyrene

Table B-2
ANNOTATED BIBLIOGRAPHY

1. Federal Register, Vol. 47, No. 43, pp. 9350-9358, Thursday, March 4, 1984.

Proposed Primary Drinking Water Regulation for Volatile Organic Chemicals.

2. Masters, G.M., Introduction to Environmental Science and Technology, John Wiley and Sons, Inc. (1974).
3. Lewis, R.J. (ed), Registry of Toxic Effects of Chemical Substances, 9th ed., U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, Cincinnati (1979).

An exhaustive review of the known toxic and biological effects of chemical substances. An excellent source of toxicity data.

4. Sax, N.I., Dangerous Properties of Hazardous Materials, 5th ed., Van Nostrand Reinhold Company, New York (1979).

A source of toxicity data. Descriptive source of hazardous properties and biological effects.

5. Sax, N.I., Cancer Causing Chemicals, Van Nostrand Reinhold Company (1981).

Thorough review of human and animal carcinogenicity data.

6. Verschueren, K., Handbook of Environmental Data on Organic Chemicals, Van Nostrand Reinhold Company (1977).

Identifies possible sources and use of organic chemicals. Provides some toxic data.

7. Water-Related Environmental Fate of 129 Priority Pollutants, U.S. Environmental Protection Agency, EPA 440/4-79-029, Vol. I and II, Office of Planning and Water Standards, Washington, D.C. (1979).

Exhaustive review of literature pertaining to the environmental fate of priority pollutants.

8. Weiss, G. (ed), Hazardous Chemicals Data Book, Noyes Data Corporation (1980).

Source of human, animal and aquatic toxicity information. Most information is qualitative.

9. Windholz, M. (ed), The Merck Index, 9th edition, Merck & Company, Inc. (1976).

Identifies possible sources and uses of chemicals. Some hazard information and toxic data provided.

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Table B-3
LIST OF ABBREVIATIONS

| <u>Abbreviation</u> | <u>Definition</u> |
|---------------------|---|
| CNS | Central nervous system |
| hmn | Human test species |
| inh | Inhalation as route of administration |
| ivn | Administered by intravenous route |
| man | Adult man as test species |
| mus | Mouse as test species |
| NIOSH | National Institute of Occupational Safety and Health |
| orl | Ingestion, either intragastric, through feeding, or introduction with drinking water. |
| rbt | Rabbit as test species |
| scu | Subcutaneous, administration under the skin. |
| skn | Application onto skin, either intact or abraded. |

Table B-4
DEFINITIONS OF TOXICITY TERMINOLOGY

- TDLo-Toxic Dose Low - the lowest dose of a substance introduced by any route, other than inhalation, over any given period of time and reported to produce any toxic effect in humans or to produce carcinogenic, neoplastigenic, or teratogenic effects in animals or humans.
- TCLo-Toxic Concentration Low - the lowest concentration of a substance in air to that humans or animals have been exposed for any given period of time and reported to produce any toxic effects in humans or to produce carcinogenic, neoplastigenic, or teratogenic effects in animals or humans.
- LD50-Lethal Dose Fifty - Calculated dose of a substance introduced by any route, other than inhalation, that is expected to cause the death of 50% of an entire experimental animal population.
- LDLo-Lethal Dose Low - the lowest dose (other than LD50) of a substance introduced by any route, other than inhalation, over any given period of time reported to caused death in humans or animals.
- LC50-Lethal Concentration 50 - a calculated concentration of a substance in air, exposure to that for a specified length of time is expected to cause the death of 50% of an entire defined experimental animal population.
- LCLo-Lethal Concentration Low - the lowest concentration, other than LC50, of a substance in air that has been reported to have caused death in humans or animals.
- TLm- Median Tolerance Limit - means that approximately 50 percent of an entire defined experimental population will show abnormal behavior (including death) under the stated conditions of concentration and time.

Table B-5
MISCELLANEOUS DEFINITIONS

Carcinogen - Agent that causes the production of malignant tumors.

Equivocal Tumorigenic Agent - Agent for that published studies report seemingly positive, but uncertain, results of tumorigenic activity.

Mutagen - A chemical agent capable of producing heritable changes in a chromosome.

Neoplastic - Agent that causes the production of benign tumors.

Teratogen - Agent capable of producing changes in the offspring from direct action on the fetus.

Compound: Antimony

EPA HWN: Not listed.

Synonyms:

Sources:

Used in manufacturer of alloys, hard lead, white metal, type, bullets and metal bearings, fireworks, thermoelectric piles, coating metals, etc.

Environmental Fate:

Transport of dissolved antimony to the oceans is the most probable dominant fate of antimony introduced into the aquatic environment. Coprecipitation, adsorption by mineral surfaces, and bioaccumulation may also be responsible for removing some antimony from solution.

Hazard Description:

Oral LD50 in rats of 100 mg/kg. Antimony and its compounds cause dermatitis, keratitis, conjunctivitis, and nasal septal ulceration by contact, fumes, or dust. Can react with nascent hydrogen to form stibine (SbH_3) which is very toxic.

Compound: Arsenic Compounds

EPA HWN: Several appear on hazardous waste list.

Synonyms:

Sources:

Used as herbicides, insecticides, and rodenticides.

Environmental Fate:

Arsenic is extremely mobile in the aquatic environment and cycles through the water column, sediments and biota. In most cases, the sediments and oceans are the primary sink for arsenic.

Hazard Description:

Most forms of arsenic are toxic. Trivalent arsenic is more toxic than pentavalent arsenic. Arsenic trioxide is extremely toxic with an oral LD50 in rats of 45 mg/kg. Acute poisoning usually results from ingestion. Chronic poisoning can occur either from ingestion or inhalation. Chronic poisoning result in disturbances of the digestive system, blood and CNS, skin abnormalities, and degeneration of liver and kidneys.

Compound: Barium

EPA HWN: D005

Synonyms:

Sources:

Carrier for radium; used in uranium rods for nuclear power plants, in radiography and in alloys for electronic tubes.

Environmental Fate:

Hazard Description:

Sulfide, oxide, and carbonate salts are eye, nose, throat, and skin irritants, producing dermatitis. All water soluble barium compounds are poisonous.

Compound: Cadmium

EPA HWN: D006

Synonyms:

Sources:

Mine drainage; cadmium is usually found in association with zinc. Used for electroplating; in plastics, pigments electrical contacts, alloys, and nickel-cadmium batteries.

Environmental Fate:

Cadmium is relatively mobile in the environment. In polluted waters, complexation with organic materials is the most important fate process. Sorption to bed sediments, onto suspended organic matter and mineral surfaces, coprecipitation, and isomorphous substitution into carbonate minerals all reduce dissolved cadmium concentrations in the environment. Cadmium is strongly accumulated by all organisms.

Hazard Description:

Cadmium and its salts are highly toxic via ingestion and inhalation (for cadmium: orl-rat LD50: 225 mg/kg; inh-hmn LCLo: 39 mg/m³/20 min). Causitive agent in itai-itai disease. An estimated 100 deaths attributable to itai-itai disease occurred in Japan from 1946-1965. Evidence that chronic exposure to low levels reduces lifespan. Many cadmium compounds are experimental carcinogens and neoplasms of connective tissues, the lung, and the liver. Some compounds show evidence of being teratogenic.

Compound: Chromium

EPA HWN: D007

Synonyms:

Sources:

Environmental Fate:

In aquatic environments both Cr(III) and Cr(VI) are stable. Hexavalent chromium is quite soluble and reacts with reducing materials to form trivalent chromium. Hydrolysis of trivalent chromium to insoluble chromium hydroxide is thought to be the dominant fate of chromium in the aquatic environment. Chromium is readily bioaccumulated in fatty tissue and is transferred through the food chain.

Hazard Description:

Elemental chromium and trivalent chromium compounds show low toxicity. Hexavalent chromium compounds are more toxic. Chromic acid and its salts have a corrosive action on the skin and mucous membranes. Chromate salts are recognized carcinogens of the lungs, nasal cavity, paranasal sinus, sinus, larynx and stomach.

Compound: Copper

EPA HWN: Not listed

Synonyms:

Sources:

Used in manufacturer of copper alloys, electrical conductors, ammunition, copper salts, and art works. Copper compounds used as fungicides.

Environmental Fate:

Complex formation, especially with humic substances; sorption to hydrous metal oxides, clays, and organic material; and bioaccumulation are important fate processes of copper in aquatic environments. The dominant process is determined by pH, Eh, concentration of organic materials and adsorbents, metal oxide concentration, biological activity, and the presence of competing heavy metals.

Hazard Description:

Copper itself is probably not very toxic. Copper compounds may be toxic. Soluble salts are strong irritants to the skin and mucous membranes. Copper oxide fumes are irritating to the eyes and upper respiratory tract and can cause metal fume fever. Hemolysis of red blood cells has been associated with inhalation of copper dust. Copper is a suspected carcinogen and mutagen.

Compound: Free Cyanides (HCN or CN^-)

EPA HWN: P063

Synonyms:

Hydrocyanic acid, hydrogen cyanide, prussic acid; cyanide ion.

Sources:

The compressed gas is used as an insecticide and rodenticide. From dissociation of cyanide salts, transformation of cyanide compounds.

Environmental Fate:

Undissociated hydrocyanic acid is the predominant species under most conditions in the aquatic environment. Hydrocyanic acid can be biodegraded by all microorganisms. However, most microorganisms can tolerate only low concentrations of cyanide. Hydrocyanic acid can also be removed by volatilization and adsorption. Cyanide ion can react with metals to form insoluble metal cyanides.

Hazard Description:

Molecular HCN is the predominant species at neutral pH and is the far more toxic of the two species. Both the liquid and vapor are irritating to the eyes. Hydrocyanic acid is extremely toxic via oral, inhalation, and dermal routes (oral-hmn LDLo: 0.57 mg/kg; inh-hmn LCLo: 107 ppm/1 hr). Following acute exposure death is extremely rapid. Exposures to concentrations of 100 to 200 ppm for 30 to 60 minutes can be fatal. Prolonged exposure may cause fatigue and weakness.

Molecular HCN is toxic to aquatic organisms at very low concentrations (young bass/TLm: 0.16 mg/L /72 hr/fresh water; pin perch/TLm 0.069 mg/L /24 hr/salt water). The toxicity of CN^- is less than that of HCN and is usually unimportant because most of the free cyanide exists as molecular HCN under normal conditions.

Compound: Lead

EPA HWN: D008

Synonyms:

Sources:

Used as a construction material; in the manufacture of sulfuric acid, tetraethyl lead, organic and inorganic lead compounds; for radiation protection; in batteries, ceramics, plastics, electronic devices, and metallurgy.

Environmental Fate:

Sorption into the sediment appears to be the dominant fate of soluble lead. Biomethylation by benthic microbes can provide a mechanism for remobilization of lead. Lead is generally not biomagnified.

Hazard Description:

Poisoning characterized by rise in blood and urine lead levels. Acute poisoning most common in children whereas chronic poisoning also affects adults. Permanent brain damage and CNS effects. Suspected carcinogen of lungs and kidneys. An experimental teratogen.

Compound: Manganese

EPA HWN: Not listed

Synonyms:

Sources:

The manufacture of steel.

Environmental Fate:

Hazard Description:

Manganese dust and fumes are highly toxic via inhalation (ihl-hmn TCLO: 11 mg/m³). Prolonged exposure to the dust is reported to increase the incidence of respiratory illness and result in chronic manganese poisoning. The CNS is the chief site of damage and exposure may result in permanent disability. Manganese is a known mutagen and a suspected carcinogen.

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Compound: Mercury

EPA HWN: D009

Synonyms:

Sources:

Plastics industry, chlorine production. Used in instrumentation devices, mercury arc lamps; in switches, fluorescent lamps, mercury boilers; the manufacture of mercury salts, mirrors; as a chemical catalyst; and many other uses.

Environmental Fate:

The majority of dissolved mercury is removed by adsorption onto the surfaces of particulates and subsequent settling to the bed sediments. Biotransformation may release mercury into the water column. Benthic organisms can convert inorganic mercury to the highly toxic methylmercury.

Hazard Description:

Elemental mercury has a relatively low toxicity (oral-hmn LDLo: 1,429 mg/kg). The vapor is known to cause CNS effects. Soluble salts have corrosive effects on the skin and mucous membranes. Acute poisoning can lead to kidney damage and death within 10 minutes. Chronic poisoning may cause irritation of mucous membranes, kidney damage, and CNS effects. Mercury is an experimental neoplastic. Organic mercury compounds can be very toxic. Alkyl mercurials are known to cause permanent brain damage.

Elemental mercury is toxic to aquatic organisms at very low concentrations (caragius ardiu/TLM: 0.5-1 mg/L/48 hr/fresh water; marine fish/TLM: 0.29 ppm/48 hr/salt water).

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Compound: Nickel

EPA HWN: Not listed

Synonyms:

Sources:

Used for nickel plating, alloys, coins, electrotypes, storage batteries, magnets, lighting rod tips, electrical contacts and electrodes, spark plugs, machinery parts; as a chemical catalyst.

Environmental Fate:

Nickel appears to be a relatively mobil heavy metal. Sorption and precipitation are important fate processes with nickel; however, neither process reduces nickel below toxic levels. Nickel is bioaccumulated, but partitioning into the biota is not a dominant fate process.

Hazard Description:

Nickel and most nickel salts are not systemic poisons. Nickel, in the form of nickel compounds, may cause dermatitis in sensitive individuals. Ingestion of large doses of soluble nickel salts will cause intestinal disorders. All airborne nickel-containing dusts are regarded as carcinogenic via inhalation.

A021454

Compound: Silver

EPA HWN: Not listed

Synonyms:

Sources:

Used in alloys and jewelry; for electroplating and photography. Has been used to disinfect drinking water because of its toxicity to bacteria and lower forms of life.

Environmental Fate:

It appears that in the aquatic environment, the main control on silver mobility is sorption by manganese dioxide, clays, ferric hydroxide, and organic materials. These mechanisms are effective in reducing the concentration of dissolved silver and result in higher concentrations in the bed sediments than the overlying water. Bioaccumulation removes some silver but is apparently strongly related to habitat (water column and benthos) and distribution of biota. Small amounts of soluble silver are transported in solution to the oceans.

Hazard Description:

Does not cause severe toxic manifestations in humans, but prolonged exposure of silver compounds can lead to discoloration of the skin. Many silver salts are irritating to skin and mucous membranes.

Silver is highly toxic to aquatic bacteria, invertebrates and fish. In aquatic systems, the toxicity of silver ranks second only to mercury among the heavy metals.

A021455

Compound: Selenium

EPA HWN: D010

Synonyms:

Sources:

Used in photograph; electrodes, electrical instruments; as paint pigments, chemical catalysts, vulcanizing agent; and many other uses.

Environmental Fate:

In aerobic waters, most selenium is transported to the oceans as soluble selenite or selenate. Sorption or precipitation onto bed sediments and suspended solids is also possible. In reducing environments, formation of insoluble metal selenides and partitioning to the bed sediments is probable.

Hazard Description:

Elemental selenium has a low acute systemic toxicity. The dust can cause serious irritation of the respiratory tract. Long-term exposure may cause CNS effects, gastrointestinal disturbances, dermatitis, liver damage, and may be a cause of amyotrophic lateral sclerosis in humans. Suspected carcinogen of liver and thyroid. Organic selenium compounds can be very toxic. The selenide, selenate, selenite, and sulfate selenium compounds are experimental carcinogens and neoplastics.

A021456

Compound: Zinc

EPA HWN: Not listed

Synonyms:

Sources:

Used to galvanize iron; in alloys, corrosion resistant metals, electrical apparatus, household utensils, castings, printing plates, and many other uses.

Environmental Fate:

Most of the zinc introduced into the aquatic environment is partitioned into the sediments by sorption. Zinc is bioaccumulated in all organisms but biomagnification is not significant.

Hazard Description:

Elemental zinc is nontoxic. Fumes may cause disease known as "brass founders ague." Other than stomach disorders, does not appear to have any cumulative effect from prolonged exposure. Zinc compounds generally are of low toxicity. Zinc salts are known or suspected carcinogens.

A021457

Compound: Dichloromethane

EPA HWN: U080

Synonyms:

Methylene chloride; methylene dichloride; methylene bichloride.

Sources:

Used as a solvent, refrigerant; in manufacture of aerosols, photographic film, synthetic fibers, coatings, plastics, pharmaceuticals; in organic synthesis.

Environmental Fate:

Volatilization is the major transport process for the removal of dichloromethane from aquatic systems. Experimental measures of volatilization half-lives range from 23 to 90 minutes. Atmospheric reactions determine the ultimate fate of dichloromethane.

Hazard Description:

Moderately toxic by ingestion (orl-rat LD50: 2136 mg/kg). The vapors are toxic if inhaled and very dangerous to the eyes. Vapors are strongly narcotic at high concentrations. Prolonged skin contact can cause dermatitis. This compound is an experimental carcinogen.

The effect of low concentrations of dichloromethane on aquatic life is unknown.

A021458

Compound: Trichloromethane

EPA HWN: U044

Synonyms:

Chloroform

Sources:

Production of refrigerants, propellants, plastics, anesthetics, pharmaceuticals, and electronic circuitry. Used as a fumigant, insecticide, and solvent.

Environmental Fate:

Volatilization is the major transport process for the removal of trichloromethane from aquatic systems. Experimental measurements of volatilization half-lives range from 19 to 90 minutes. Atmospheric reactions determine the ultimate fate of trichloromethane.

Hazard Description:

Vapor is irritating to eyes, nose, and throat. Liquid is irritating to skin and eyes. Moderately toxic via ingestion (orl-rat LD50: 800 mg/kg). Effects of prolonged inhalation are narcosis, liver and kidney damage, and possibly death. Experimental neoplastic and carcinogen.

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Compound: Trichlorofluoromethane

EPA HWN: U121

Synonyms:

Trichloromonofluoromethane; trichlorofluoromethane;
fluorotrichloromethane; Freon II; Frigen II;
fluorocarbon-11; Ucon-11.

Sources:

Used in refrigeration machinery and as an aerosol propellant.

Environmental Fate:

Rapid volatilization is thought to be the major transport process for removal of this compound in the aquatic environment. Evidence for adsorption, bioaccumulation, hydrolysis, and biodegradation is inconclusive. Volatilized trichlorofluoromethane eventually reaches the stratosphere where it undergoes photodestruction or is reintroduced into surface waters by precipitation.

Hazard Description:

Vapor is mildly irritating. Liquid is not harmful. Low toxicity via inhalation route (inh-hmn TCLo: 50,000 ppm/30 min).

Trichlorofluoromethane is not harmful to aquatic life.

A021460

Compound: Chloroethane

EPA HWN: Not listed.

Synonyms:

Ethyl chloride; monochloroethane; hydrochloric ether; muriatic ether; chloroethyl

Sources:

Used as a refrigerant, solvent, alkylating agent, in production of tetraethyllead.

Environmental Fate:

Limited information in the literature indicates that the important fate processes are volatilization and hydrolysis.

Hazard Description:

Mildly irritating to eyes, nose, throat, and skin. Inhalation of high concentrations is narcotic (inh-human LCLo: 13,000 ppm). Least toxic of all chlorinated hydrocarbons.

A021461

Compound: 1,1-Dichloroethane

EPA HWN: U076

Synonyms:

Ethylidene chloride; ethylidene dichloride; chlorinated hydrochloric ether.

Sources:

Environmental Fate:

Volatilization followed by rapid atmospheric reactions appears to be the dominant fate of 1,1-dichloroethane.

Hazard Description:

Irritating to the skin. Moderately toxic via oral route (orl-rat LD50: 725 mg/kg). A narcotic at high concentrations. Injury to liver and kidneys reported in experimental animals. An experimental teratogen.

Toxic to aquatic life at high concentrations (brine shrimp/ TLm: 320 mg/L /24 hr; pin perch/TLm: 160 mg/L /24 hr).

A021462

Compound: 1,1,1-Trichloroethane

EPA HWN: U226

Synonyms:

Methylchloroform; chloroethene; alpha-trichloroethane, and various trade names.

Sources:

A cleaning agent for metal and plastic molds.

Environmental Fate:

Published information indicates that volatilization followed by rapid atmospheric reactions is the dominant fate of 1,1,1-trichloroethane. Evidence concerning the importance of adsorption, bioaccumulation, and biodegradation as fate processes is inconclusive.

Hazard Description:

The vapor is irritating to the eyes, nose, and throat. Liquid is irritating to the skin and eyes. Moderately toxic via oral and inhalation routes (orl-man TCLo: 670 mg/kg; inh-man TCLo: 920 ppm/70 min). Animal exposure at high doses via inhalation causes immediate CNS effects. A lower single dose or chronic exposure resulted in abnormalities of liver, kidneys, lungs, heart, adrenals, and gastrointestinal tract. A positive animal carcinogen.

1,1,1-Trichloroethane is toxic to aquatic life at moderate concentrations (pin fish/TLM: 70-150 mg/L /? ^a hr/salt water).

^aTime of exposure not specified.

A021463

Compound: Chloroethene

EPA HWN: Not listed.

Synonyms:

Vinyl chloride; monochloroethylene; chloroethylene, monovinyl chloride; and MVC.

Sources:

Used in plastics; as a refrigerant; in organic synthesis.

Environmental Fate:

Published information indicates that rapid volatilization followed by rapid photodestruction is the ultimate fate of chloroethene in the aquatic environment.

Hazard Description:

Strongly irritating to respiratory system, eyes, nose, and skin. Rapid evaporation can cause frostbite. Moderately toxic via oral route (orl-rat LD50: 500 mg/kg). Chronic exposure via inhalation has caused liver injury in experimental animals. Narcotic in high concentrations. A positive animal carcinogen via oral and inhalation routes. Readily absorbed via the gastrointestinal tract, accumulates in the liver and is known to be a potent a human carcinogen, teratogen and mutagen. Causes liver hemangiosarcoma, cancer of the lung and brain, mammary carcinomas and birth defects. Exposure occurs via inhalation of vapor and possibly by dermal exposure. Exhibits a latency period of 10-30 years.

A021164

Compound: 1,1-Dichloroethene

EPA HWN: U078

Synonyms:

1,1-Dichloroethylene; vinylidene chloride; asym-dichloroethylene.

Sources:

Intermediate in the production of "vinylidene plastics".

Environmental Fate:

Published studies indicate that volatilization followed by atmospheric reactions is the dominant fate for 1,1-dichloroethene in the aquatic environment.

Hazard Description:

Vapor is irritating to skin and mucuous membrane; a narcotic. Liquid will burn skin and eyes. Highly toxic via oral route (orl-rat LD50: 200 mg/kg). Highly toxic via inhalation route (inh-hmn LCLo: 25 ppm). Experimental carcinogen via inhalation route. Liver and kidney damage in animals from chronic exposure.

A021465

Compound: trans-1,2-Dichloroethene

EPA HWN: U079

Synonyms:

1,2-Dichloroethylene; acetylene dichloride,
trans-dichloroethylene.

Sources:

Solvent for organic substances; constituent in refrigerants
and thermoplastics.

Environmental Fate:

Published studies indicate that rapid volatilization followed
by rapid photodestruction is the ultimate fate for
trans-1,2-dichloroethene in the aquatic environment.

Hazard Description:

Contact with liquid causes irritation of eyes and skin and
may cause dermatitis. Moderately toxic via ingestion
(orl-rat LD50: 770 mg/kg). Ingestion causes slight
depression to deep narcosis. Slightly toxic via inhalation
(inh-rat LCLo: 10,000 ppm/24 hr).

The effect of low concentrations of 1,2-dichloroethene on
aquatic life is unknown.

A021466

Compound: Trichloroethene

EPA HWN: U228

Synonyms:

Trichloroethylene; TCE; 1,1,2-trichloroethylene; 1,2,2-trichloroethylene; 1-chloro-2,2-dichloroethylene; 1,1-dichloro-2-chloroethylene; ethynyl trichloride; trichloride; ethylene trichloride, triclène, and various trade names.

Sources:

Manufacture of organic chemicals and pharmaceuticals. Used in dry cleaning operations and metal degreasing; as solvent for fats, greases, waxes, cellulose ester and ethers, dyeing, for caffeine in coffee and in solvent extraction. A refrigerant and heat exchange liquid.

Environmental Fate

Volatilization appears to be the dominant transport process for removal of trichloroethene from aquatic environments (50% evaporation from water at 25°C after 19-24 min). Once the compound enters the atmosphere, it readily undergoes oxidation by hydroxyl radicals. There is some evidence of bioaccumulation of trichloroethene in marine organisms, but the process is probably not important relative to volatilization as a removal mechanism. There is, however, no evidence for biomagnification in aquatic food chains. In addition, no evidence has been found to suggest that adsorption to sediments is an important fate process.

Hazard Description:

Trichloroethene vapor is irritating to the eyes, nose and throat. The liquid is irritating to the skin and eyes. Trichloroethene is moderately toxic via inhalation and oral routes (inh-hmn TCLo: 160 ppm/83 mm; orl-hmn LDLo: 857 mg/kg; orl-rat LD50: 4920 mg/kg). Moderate exposure to the vapors can cause symptoms similar to alcohol inebriation. Inhalation of high concentrations cause narcosis and amesthesia. A form of addiction has been observed following prolonged exposure to the vapors. Acute exposure to trichloroethene may cause cardiac failure. Prolonged exposure results in damage to the liver and other organisms. Trichloroethene is readily absorbed into the blood stream when ingested. In the body, trichloroethene will be metabolized. Its metabolites appear to have moderate bioaccumulative properties. An epoxide intermediate, 2,2,3-trichloroxirane, is thought to be responsible for its mutagenic and carcinogenic potential. Trichloroethene is a positive animal carcinogen.

Trichloroethene is toxic to aquatic organisms at high concentrations (daphnia/TLm: 660 mg/L /40 hr). The effect of low concentrations on aquatic life is unknown.

Compound: Tetrachloroethene

EPA HWN: U210

Synonyms:

Tetrachloroethylene; perchloroethylene; PCE; ethylene tetrachloride; carbon dichloride.

Sources:

Dry cleaning and metal degreasing operations, manufacturing of fluorocarbons. Solvents for various organic substances.

Environmental Fate

Published studies indicate that volatilization followed by atmospheric reactions is the predominant fate for tetrachloroethene in the aquatic environment. Metabolization by higher organisms and bioaccumulation in marine organisms has been evidenced.

Hazard Description:

Vapor is irritating to the eyes, nose, and throat. Low toxicity via ingestion (orl-rat LD50: 8.85 g/kg). Moderate toxicity via inhalation (inh-human TCLo: 96 ppm/7 hr). Affects liver, kidneys, eyes, upper respiratory system, and CNS. Metabolites bioaccumulate to some degree during continued exposure. A positive animal carcinogen.

The effect of low concentrations of tetrachloroethene on aquatic life is unknown.

Compound: Benzene

EPA HWN: U109

Synonyms:

Benzol; cyclohexatriene; coal tar naptha; phenyl hydride.

Sources:

Produced by petroleum refineries, solvent recovery plants; during coal tar distillation, coal processing, and coal coking. Used in the manufacturer of a wide range of consumer and industrial products.

Environmental Fate:

It appears that the predominant mechanism for removal of benzene from the water column is volatilization to the atmosphere. The half-life with respect to volatilization from a water column one meter thick has been estimated to be 4.81 hours at 25°C. The role of sorption onto sediments and suspended solids has not been established. Gradual biodegradation by aquatic organisms has been evidenced. Bioaccumulation is low.

Hazard Description:

Vapor is irritating to eyes, nose, and respiratory system. Liquid is irritating to skin and eyes. Local irritant effects are strong. Harmful amounts may be absorbed through skin. Moderately acute toxicant via oral and inhalation routes (orl-hmn TDLo: 130 mg/kg; inh-hmn TCLo: 210 ppm). Inhalation of high concentrations may be narcotic. A severe chronic toxicant. Toxic effects upon blood, CNS, skin, bone marrow, eyes and respiratory system. Can also induce chromosomal abberations in humans.

Benezene is harmful to aquatic life in very low concentrations (minnow/5 mg/L /6 hr/lethal/distilled water; sunfish/TLm: 20 mg/L /24 hr/tap water).

Compound: Toluene

EPA HWN: U220

Synonyms:

Methylbenzene; toluol; phenylmethane; methacide.

Sources:

Produced during petroleum refining and coal tar distillation.

Environmental Fate:

The principal mechanism for the removal of toluene from water appears to be volatilization with a half-life of approximately 5.18 hours in the atmosphere. Adsorption onto sediments and suspended solids is probable but quantitatively undefined. Insufficient information exist to evaluate biodegradation by aquatic microorganisms. Some species of soil bacteria are capable of using toluene as a sole carbon source.

Hazard Description:

Irritating to eyes and skin. Low toxicity via oral and dermal routes (orl-rat LD50: 5,000 mg/kg). Moderate toxicity via inhalation (inh-man TCLO: 100 ppm). CNS and psychotropic effects from inhalation. Toxic effects on liver and kidneys.

Toluene is moderately toxic to aquatic life (fatheads/TLm: 56-34 mg/L /24-96 hr; goldfish/TLm: 57.7 mg/L /24-96 hr).

Compound: Diethyl phthalate

EPA HWN: U088

Synonyms: Ethylphthalate; DEP.

Sources:

Used in plastics, explosives, food packaging, dyes, dental work, insecticides, and other commercial products.

Environmental Fate:

Bioaccumulation, biotransformation, and biodegradation are probable fate processes for diethyl phthalate in the environment. Sorption onto suspended solids and formation of water soluble complexes with humic substances are also probable fates. It is not possible to predict the dominant fate process at this time.

Hazard Description:

Irritant of mucous membranes and eyes. Narcotic at high concentrations. An experimental animal teratogen.

Toxic to aquatic life in very low concentrations
(goldfish/TLM: 1.2 mg/L /30 min/killed/fresh water).

Compound: Chrysene

EPA HWN: U050

Synonyms:

1,2-Benzophenanthrene; benz(a)phenanthrene

Sources:

Found in coal tar

Environmental Fate:

Insoluble in water. Presence in aquatic systems probably due to adsorption onto sediments, suspended particulates and biota. Biodegradation and biotransformation by benthic organisms probable.

Hazard Description:

Limited data indicates high toxicity (scu-mus TDLo: 200 mg/kg). An experimental animal carcinogen and neoplastic.

Compound: Fluoranthene

EPA HWN: U120

Synonyms:

Idryl

Sources:

Soot, coal tar, pitch.

Environmental Fate:

Low solubility in water. Dissolved portion undergoes rapid direct photolysis. Presence in aquatic environment largely due to sorption onto sediments, suspended particulates, and biota. Biodegradation and biotransformation by benthic organisms is probable.

Hazard Description:

Limited animal experiments indicate moderate toxicity via oral and dermal routes (orl-rat LD50: 2,000 mg/kg; skn-rat LD50: 3,180 mg/kg). An experimental tumorigenic agent.

Compound: Acetone

EPA HWN: U002

Synonyms:

Dimethylketal; dimethyl ketone; 2-propanone; beta-ketopropane; pyroacetic ether.

Sources:

Used as a solvent; in organic synthesis; in sealants and adhesives; and in manufacture of paint, varnishes, and lacquers.

Environmental Fate:

Hazard Description:

Vapor is irritating to the eyes, nose, and throat. Liquid is mild irritant to skin, severe irritant to eye. Moderately toxic via inhalation (inh-hmn TCLO: 500 ppm). Inhalation of large amounts may be narcotic. Slightly toxic via oral and dermal routes (orl-rat LD50: 9,750 mg/kg). Prolonged or repeated contact with skin may cause erythema, dryness.

Dangerous to aquatic life in very high concentrations (sunfish 14,250 mg/L /24/hr/tap water/killed; mosquito fish TLm: 13,000 mg/L /48 hr/turbid water).

Compound: 2-Butanone

EPA HWN: U159

Synonyms:

Methyl ethyl ketone; MEK; ethyl methyl ketone and methyl acetone.

Sources:

Organic chemical industry. General use as solvent; evaporation of paints and coatings, cements, adhesives; in cleaning fluid and lab use. In manufacture of synthetic resins and smokeless powders.

Environmental Fate:

Hazard Description:

2-Butanone vapors are strongly irritating to the eyes, nose, and throat and the liquid will burn the eyes. 2-Butanone is moderately toxic via inhalation and oral routes and of low toxicity via the dermal route (ihl-hmn TCLo: 100 ppm/5 min; ihl-rat LCLo: 2,000 ppm/4 hr; orl-rat LD50: 3,400 mg/kg; skn-rbt: LD50 13 gm/kg). 2-Butanone affects the CNS and peripheral nervous system and is an experimental teratogen.

2-Butanone is dangerous to aquatic life at high concentrations (bluegill/TLm: 5,640 mg/L /48 hr).

Compound: Isophorone

EPA HWN:

Synonyms:

3,5,5-trimethyl-2-cyclohexene-1-one;
1,1,3-trimethyl-3-cyclohexene-5-one; isoactophrone;
isophoron.

Sources:

Used as intermediate for alcohols, raw material for 3,5-dimethyl aniline and manufacture of pesticides. Used as a solvent for nitrocellulose resins, lacquers, and finishes.

Environmental Fate:

No quantitative information is available to assess the aquatic fate of isophorone. The moderate water solubility (12,000 ppm) and relatively low volatility of isophorone indicates that it should remain in the water column until transformation reaction(s) occur. Biological and photochemical reactions could be important processes in removing isophorone from aquatic systems.

Hazard Description:

Both the liquid and vapor are strong irritants to the eyes, nose, and throat. Contact with the liquid can cause tissue damage. Isophorone is moderately toxic via oral, dermal, and inhalation routes (orl-rat LD50: 2,330 mg/kg; skn-rbt LD50: 1,500 mg/kg; inh-hmn LCLo: 25 ppm). Response of experimental animals exposed to repeated inhalation of isophorone vapors indicates that it is one of the most toxic of the ketones. However, due to its relatively low volatility it is not generally considered an industrial hazard. In animal experiments, death usually occurs due to narcosis, but occasionally due to irritation of the lungs.

Isophorone is toxic to aquatic organisms at high concentrations (brine shrimp/TLm: 430 mg/L /24 hr). The effect of low concentrations on aquatic life is unknown.

Compound: o-Xylene

EPA HWN: U239

Synonyms:

1,2-dimethylbenzene; o-xylol.

Sources:

Petroleum distillation, coal tar distillation, coal gas distillation; constituent in asphalt and naptha; raw material for production of polyester fibers; organic chemical industry, solvent recovery plants; used in the production of pharmaceuticals and insecticides.

Environmental Fate:

Practically insoluble in water. Volatilization of soluble o-xylene is probable with an estimated volatilization half-life on the order of a few hours. Biodegrades very slowly. Insufficient data available to determine the importance of other potential fate processes.

Hazard Description:

Vapor is irritating to the eyes, nose, and throat. Liquid is irritating to skin and eyes. Moderate toxicity via oral and inhalation routes (orl-rat LD: 5,000 mg/kg; inh-rat LCLo: 6,920 ppm). Inhalation may cause pulmonary edema, high concentrations are narcotic. Chronic toxicity not well defined, but is less toxic than benzene. Toxic effects on kidney and liver.

Toxic to aquatic life at high concentrations (D. magna/TLm: greater than 100 mg/L /96 hr/fresh water; coho salmon 100 mg/L /24 hr/artificial sea water/killed).

Compound: Styrene

EPA HWN:

Synonyms:

Vinyl benzene; phenyl ethylene; phenethylen; phenylethene; vinyl benzol, cinnamene; and various trade names.

Sources:

Organic chemical industry. Used in the manufacture of styrene and polystyrene products, synthetic rubber, ABS plastics, resins, insulators, and protective coatings.

Environmental Fate:

Hazard Description:

Styrene vapors are irritating to mucous membranes and the liquid will burn the skin and eyes. Styrene is moderately toxic via inhalation and oral routes (ihl-hmn LCLo: 10,000 ppm/30 min; inh-hmn TCLo: 376 ppm; orl-rat LD50: 5,000 mg/kg; orl-mus LD50: 316 mg/kg). Adverse effects following prolonged exposure to 0.5 mg/m³ have been observed in animal experiments. Styrene is a positive animal carcinogen.

Styrene is harmful to aquatic life at very low concentrations (bluegill/TLm: 22 mg/L /96 hr; goldfish/TLm: 26 mg/L /24/hr).

Compound: Pyrene

EPA HWN: Not listed

Synonyms:

Benzo(def)phenanthrene

Sources:

Occurs in coal tar, soot and pitch.

Environmental Fate:

Very low solubility in water. Presence in aquatic systems due largely to adsorption onto sediments, suspended particulates, and biota. Biodegradation and biotransformation by benthic organisms probable.

Hazard Description:

A skin irritant. A carcinogen on NIOSH Suspected Carcinogen List.

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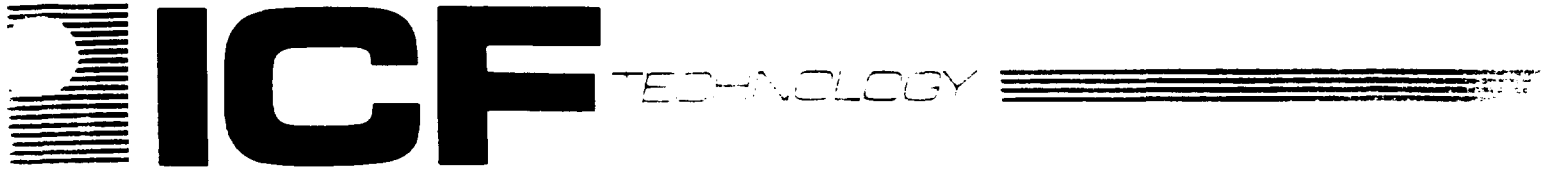
Appendix C
TOPOGRAPHIC MAP AND AERIAL PHOTOS

A021480

Appendix C
TOPOGRAPHIC MAP AND AERIAL PHOTOS

A021481

Phil Smith



MEMORANDUM

TO: Reviewers DATE: October 24, 1986

FROM: Brad Brockbank, ICF/CHI

WORK

ASSIGN. NO.: 28-5LH2.0

PROJECT NO.: W63581.CR

SUBJECT: INTERNAL DRAFT KICKOFF FACT SHEET FOR NSL/ECC SITES

Attached for your review is an internal draft of the Northside Sanitary Landfill/Enviro-Chem Corporation kickoff fact sheet. Graphics are not included in this package. Shawn McAfee (GLO) is sending them under a separate cover to Martha (WDC) and Carol (ICF/WDC), and has copies to give to Al, Phil, and Larry (GLO). Please return comments to me no later than Wednesday, October 29. In accordance with agreed-upon procedures, Site Managers and Martha should provide copies of their comments to Larry. If possible, Al and Phil should coordinate their comments with Larry to minimize the number of documents to which I must respond.

The major difference between this draft and the Seymour fact sheet, which you all have seen, is in the treatment of the alternatives. To avoid too much repetition and back-referencing, I have instead listed the specific techniques from the CAA in a single section. The alternatives are defined more succinctly, I hope, by the matrix Shawn has developed (Exhibit 5).

In addition, I hope Al and Phil will suggest some language to add depth to the rationale behind the selected remedial alternative, based on the latest thinking in the development of the final CAA. Also, please update any other changes in the alternatives since I last spoke with the two of you.

Please make special note of the Glossary. I have streamlined the definitions for leachate and PCBs from the "boilerplate" language used in other fact sheets. Some other words are new and should be checked.

Call me if you have questions.

A021553



MEMORANDUM

TO: Larry Martin
Al Sloan
Phil Smith ✓
Martha Bean

FROM: Brad Brockbank

DATE: October 16, 1986

SUBJECT: INTERNAL REVIEW OF NSL/ECC FS FACT SHEET

I will be sending you a draft fact sheet on Monday, October 20 by Federal Express. You should all receive it by Tuesday, October 21. As Larry, Martha, and I have previously discussed, the site managers and Martha should provide both Larry and me with copies of their comments. I need to receive those comments by October 23. I'll talk to Larry over the phone that afternoon and will send out a revised draft to the GLO office on October 24. I must receive comments on that revised draft by FedEx or by telephone on October 29 if I am to meet the October 31 deadline with EPA described in the attached memo.

Please call me if you have any questions or problems with this schedule. Thanks for your cooperation.

A021554



Phil Smith, SM (ECC)
CH2M/Hill (GLO)

MEMORANDUM

TO: Art Gasior, U.S. EPA Region V CRC

FROM: Brad Brockbank, ICF

DATE: October 16, 1986

SUBJECT: Schedule for Northside Landfill/Enviro-Chem FS fact sheet

This memo summarizes our discussions over the past few days about the schedule for producing the FS fact sheet for the Northside Landfill/Enviro-Chem site. Because contractor support for this site is scheduled for termination on October 31 if Superfund reauthorization is not finalized, we will try to get as far as we can by that date. Our goal is to finish an Agency Review Draft of the text and graphics for the fact sheet before the October 31 deadline. To achieve this, ICF and CH2M/Hill will make special efforts to shorten the internal review process. I will be sending out the first internal draft Friday, October 17. All hours spent on this task will be incurred only through October 31. Late on October 31 (or early on Monday, November 3 if I need to take additional time after 4:30 p.m. on Friday, October 31), I will deliver the review draft to you.

We should know well before that date, however, whether further work on the fact sheet will be performed by us or whether the revision and production of the fact sheet during November must be left to you. Assuming Superfund is reauthorized and we are able to continue to support the work at Northside, the following milestones were tentatively agreed upon:

- November 5 - Agency comments received by ICF
- November 6 - ICF submits revised Agency Review Draft to EPA
- November 13 - Final comments received by ICF
- November 14 - Draft into typesetting and production
- November 24 - Final fact sheet to EPA for mailing
- November 26 - Addressees receive fact sheet
- December 3 - Public meeting

Please call me if you have any questions.

A021555

Phil Smith



MEMORANDUM

TO: Art Gasior, Region V CRC DATE: November 18, 1986

FROM: Carol Andress
REM IV ICF Community Relations Manager

WORK
ASSIGN. NO.: 28-5LH2.0

PROJECT NO.: W63581.CR

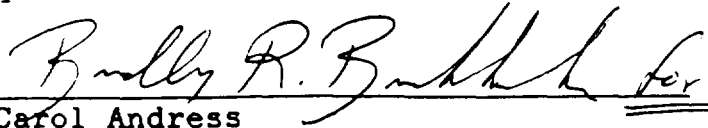
SUBJECT: AGENCY REVIEW DRAFT FS/CAA FACT SHEET FOR NSL/ECC SITES

Attached for your review is the agency review draft of the Northside Sanitary Landfill/Enviro-Chem Corporation FS/CAA fact sheet. Please return any comments to Brad Brockbank as soon as possible so that he can incorporate the changes and put the fact sheet into production.

Some important features of the proposed layout of the fact sheet include: (a) page 1 of the fact sheet will look similar to the RI fact sheet for these sites, with the site map overlain by a screened box containing site descriptions; (b) page 2 will contain the "background information" box in the lower left corner; and (c) the box entitled "Opportunities for Public Involvement" (page 15 of this draft) will stretch across the bottom of page 3.

Graphics for the fact sheet are included for your review as well. Please note that a few minor revisions to the graphics are still required: (a) changing "NSL" and "ECC" to "Northside" and "Enviro-Chem," respectively, in several places; (b) switching the labeling of the silt pond and the cooling pond in Figure 5; and (c) re-ordering one of the remedial measures in Figure 4 ("Cooling pond sludge removal") to be consistent with the order of the descriptions in the text.

Please contact Brad Brockbank in our Chicago office if you have questions.


Carol Andress
REM IV ICF Community Relations Manager

11/18/86
Date

cc: Karen Vendl, RPM
Al Sloan/Phil Smith, SMs
Larry Martin, CH2M/Hill

A021556

AGENCY REVIEW DRAFT

FS/CAA FACT SHEET

**NORTHSIDE/ENVIRO-CHEM SITES
ZIONSVILLE, INDIANA**

Work Assignment Number: 28-5LH2.0
REM IV Project Number: W63581.CR

November 17, 1986

NONDISCLOSURE STATEMENT

This document has been prepared for the U.S. Environmental Protection Agency under Contract No. 68-01-7251. The material contained herein is not to be disclosed to, discussed with, or made available to any person or persons for any reason without the prior expressed approval of the responsible official of the U.S. Environmental Protection Agency.

A021557

SUPERFUND FACT SHEET

U.S. EPA

REGION V

NORTHSIDE SANITARY LANDFILL

ENVIRO-CHEM SITE

DECEMBER 1986

ZIONSVILLE, INDIANA

U.S. EPA RECOMMENDS A REMEDY FOR NORTHSIDE AND ENVIRO-CHEM

Public Meeting: December 10, 1986, 7 p.m., at the Zionsville Town Hall,
110 South 4th Street, Zionsville, Indiana.

Public Comment Period: Comments on U.S. EPA's analysis and recommended
remedy accepted until January 24, 1987.

INTRODUCTION

The U.S. Environmental Protection Agency (U.S. EPA) recently evaluated alternative methods (known as "remedial alternatives") to resolve contamination problems at the Northside Sanitary Landfill and the neighboring Enviro-Chem Corporation Superfund sites near Zionsville, Indiana. These evaluations, called "Feasibility Studies" (FS), were begun

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A021553

AGENCY REVIEW DRAFT

- 1 -

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in Spring 1985 for the Enviro-Chem site and Spring 1986 for the Northside site. In addition, U.S. EPA also completed an analysis of combined alternatives (called the "Combined Alternatives Analysis" or CAA), which evaluates combined solutions for both sites and describes the remedial alternative U.S. EPA recommends for the sites. The combined analysis was performed as a result of the close proximity of these sites to ensure that future actions at both sites are compatible, avoid duplication, and are cost-effective.

The remedial alternative U.S. EPA is recommending for the Northside and Enviro-Chem sites includes collecting and treating leachate and contaminated groundwater, covering the sites with a multi-layer cap, excavating contaminated sediments and sludges around the sites, and preventing future access to and use of the sites. This fact sheet describes this alternative and the other alternative measures considered by U.S. EPA in the Feasibility Study reports and the Combined Alternatives Analysis for the Northside and Enviro-Chem sites.

You can find copies of these reports and other site-related information in Zionsville at the Town Hall at 110 South 4th Street, and at the Hussey Memorial Library at 255 West Hawthorne Street. Copies of the reports are also available at the U.S. EPA Region V office in Chicago. U.S. EPA encourages your review and comment on these reports and will be

A021559

holding a public meeting and a public comment period to receive comments on U.S. EPA's analysis and recommendations. Further details on the public meeting and comment period are provided on page 3.

Once the public comment period is complete, U.S. EPA will review the comments received and choose the remedial alternative to be carried out at the Northside and Enviro-Chem sites. U.S. EPA and the U.S. Department of Justice will then negotiate with companies and individuals identified as potentially responsible for the contamination at the sites for the design and development of the chosen remedial alternative. If the U.S. government cannot reach a voluntary agreement with the potentially responsible parties (PRPs), the government may seek action through the courts to get the PRPs to conduct the cleanup.

-----BOX, OVERLAPPED ON SITE MAP, PAGE 1-----
SITE DESCRIPTIONS

Northside Sanitary Landfill is an active landfill covering approximately seventy acres of a 170-acre parcel of land. Enviro-Chem, a former solvent processing and reclaiming facility, occupies almost seven acres of land immediately west of Northside. The sites are located in a rural area of Boone County, about five miles north of Zionsville and ten miles northwest of Indianapolis (Figure 1, below). Farmland borders the

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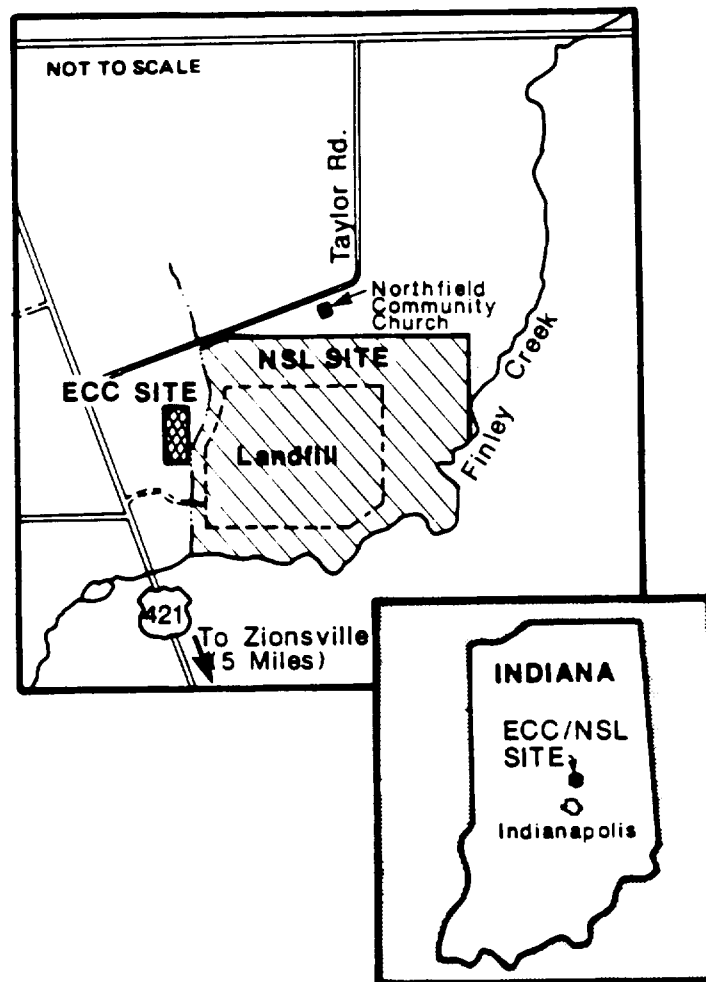
southern and eastern edges of the combined site area. Residential properties are located to the north and west, within one-half mile of the facilities. A small residential community, Northfield, is located north of the sites on U.S. Route 421. Approximately fifty residences are located within a mile of the sites.

An unnamed ditch runs north to south between the two sites, along the western edge of the landfill, and joins Finley Creek at the southwestern corner of the landfill. Finley Creek runs along the eastern and southern edge of the Northside site and flows into Eagle Creek about one-half mile downstream from the site. Eagle Creek flows south from its confluence with Finley Creek for ten miles before it empties into Eagle Creek Reservoir. The reservoir supplies approximately six percent of the drinking water for the City of Indianapolis.

-----END OF BOX-----

A0215G1

FIGURE 1
SITE LOCATION MAP



A021502

-----BOX ON PAGE TWO OF TYPESET FACT SHEET-----

BACKGROUND INFORMATION ON THE SITES

| | <u>Northside</u> | <u>Enviro-Chem</u> |
|---|---|---|
| Type of operation: | Private landfill | Recovery, reclamation and brokering agent for solvents, oils and other industrial wastes |
| Period of operation: | 1962 to present | 1977 to 1982 |
| Quantity of hazardous wastes received: | At least 16 million gallons | Total volume unknown |
| History of operational problems: | Recurrent problems: o ordered to cease operations in 1972 and 1973 by Indiana State Board of Health; o ground-water con- tamination found at southwest corner of | Investigations by Indiana State Board of Health and U.S. EPA in late 1970s indicated poor waste management and evidence of spills; Site placed under receivership in 1981. |

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site in 1982;
 o ordered to stop
 accepting liquid and
 hazardous wastes by
 Indiana Environmental
 Management Board in 1983;
 o permit applications
 to operate hazardous
 waste disposal facility
 denied in 1982 and 1983
 by State, and in 1984
 by U.S. EPA.

| | | |
|-----------------------|-------------------|--------------------------|
| Prior cleanup actions | Leachate | U.S. EPA surface cleanup |
| | collection system | completed in 1984; soil |
| | installed by site | cover placed over site. |
| | owner in 1982. | |

| | | |
|---------------------------|----------------------|----------------------|
| U.S. EPA Remedial | Conducted in 1984-86 | Conducted in 1983-86 |
| Investigation/Feasibility | | |
| Study (RI/FS) | | |

-----END OF BOX-----

ADDRESSING THE PROBLEMS AT THE SITES

The Remedial Investigation at the Northside and Enviro-Chem sites indicated that the soil at both sites is contaminated with organic and inorganic compounds (see glossary for definitions). In addition, contamination was detected in the ground water beneath the Northside site and in the sediments and surface water near the southwest corner of the Northside landfill. Based on these findings, U.S. EPA concluded that if no further actions were taken at the site, people could come in contact with contaminants from the site if they:

- o Inadvertently ingest the contaminated soil or sediments;
- o Drink ground water from under the site area that is contaminated; and
- o Consume fish from Finley Creek that have accumulated contaminants in their tissues.

In order to reduce these possible sources of human exposure, U.S. EPA identified actions that would: (1) prevent people from going onto the sites and becoming exposed to the chemicals, and (2) prevent chemicals

from moving away from the sites in high concentrations through the ground water, surface water, and soil. To achieve these objectives, U.S. EPA developed the following list of possible protective measures that could be appropriate for the two sites:

- Deed and access restrictions could be instituted that would prohibit future development on the sites or other human activity that might interfere with other protective measures on the sites. Fencing could be constructed around the sites and signs posted to prevent people from entering the sites and to prevent damage to protective structures.
- The sites could be covered with either a soil cover or a multiple-layer cap, referred to as a "RCRA cap."

-- A soil cover is a thick layer of clean soil designed to place a barrier between contaminants at the sites and the air. A soil cover, if maintained properly, prevents contaminants from blowing off the sites or being carried by runoff to the surface water, thereby reducing the chances that people might come in direct contact with contaminants from the sites.

-- A RCRA cap (pictured in Detail C of Figure 2) is a multiple-layer cap over the top of the sites that meets standards required under the Resource Conservation and Recovery Act (RCRA; see glossary). A RCRA cap, if properly maintained, prevents people from coming in contact with contaminants on the sites and reduces the amount of water filtering down through the soils, carrying contamination into the ground water and away from the sites. A RCRA cap also prevents contaminants from blowing off the sites or being carried off by runoff.

- o Contaminated sediments could be removed from the ditches surrounding the sites and placed in the Northside landfill before a cover or a cap is installed. This would prevent people from coming into direct contact with the contaminated sediments and would prevent contamination in the sediments from being washed away from the sites.
- o The unnamed ditch between the Northside site and the Enviro-Chem site could be rerouted around the west side of the Enviro-Chem site, reducing the potential for water in the ditch to carry contaminants from the sites into Finley Creek.

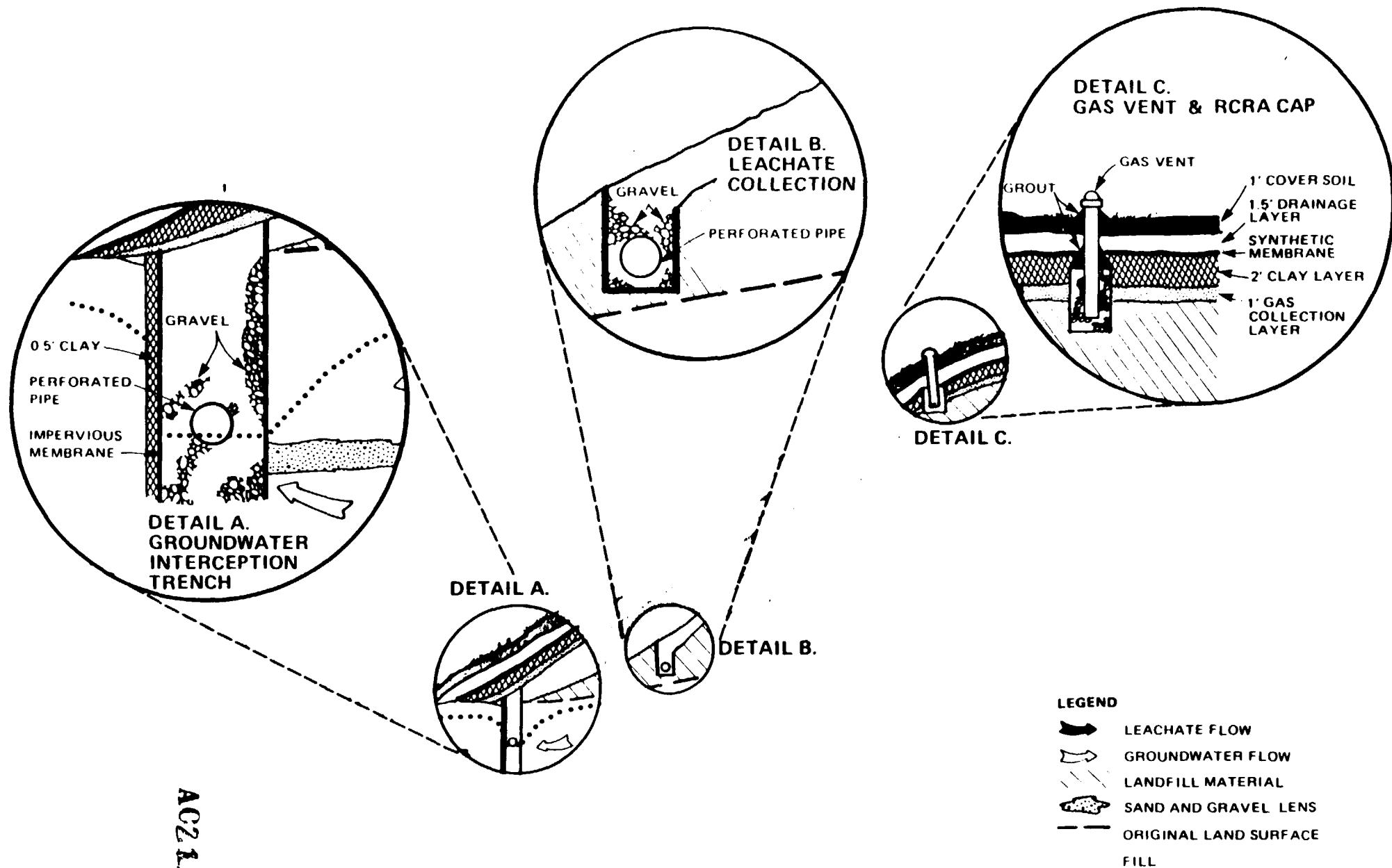


FIGURE 2
 RECOMMENDED ALTERNATIVE
 NSL NORTH-SOUTH CROSS SECTION
 (with details)

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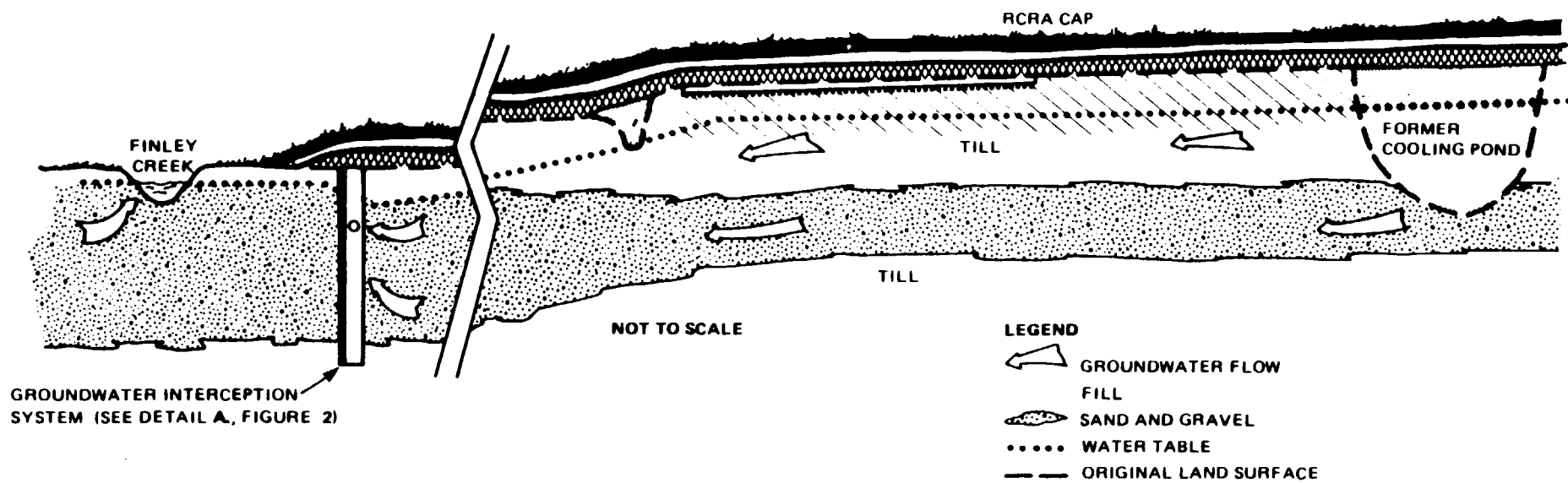
- o Contaminated liquid seeping from the landfill ("leachate") could be collected and treated to prevent the spread of contaminants in ground or surface waters. A leachate collection system uses perforated pipes laid in trenches ("French Drains") surrounding the landfill to capture leachate. A cross section of a leachate collection system for the Northside site is shown in Figure 2 (Detail B). Leachate collected by this system would then be treated in a two-stage treatment system to remove the contaminants. In the first stage, metals and other inorganic chemicals would be allowed to settle out of the contaminated liquid -- a process known as "precipitation." In the second stage, other contaminants would be removed by a process combining biological treatment and carbon adsorption (known as "Powdered Activated Carbon Treatment"). Biological treatment would involve the use of microorganisms that ingest some of the organic compounds. The remaining organic compounds would stick ("adsorb") to the surface of the carbon in the system. Contaminated biological and metal sludges remaining after treatment would then be disposed of at a licensed facility. The cleaned water would be discharged into Finley Creek after the appropriate permits were obtained.

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- o Ground water interception and treatment systems could be used to "intercept" contaminated ground water moving away from the site before contaminants reach the surface water or drinking water wells. Figures 2 (Detail A) and 3 show cross sections of ground water interception systems proposed for the Northside and Enviro-Chem sites, respectively. French Drains (similar to ones used in the leachate collection system, but deeper) would be used to collect and transport the contaminated ground water to the two-stage treatment system described for leachate.

- o Systems to isolate the ground water ("ground-water isolation") could be installed to collect water in French Drains. The French Drains used in ground-water isolation would be even deeper than the French Drains used in the ground-water interception system. After about five years of collection, the level of the ground water should be lower than the contaminated soil layers, restricting the movement of contaminants away from the sites. Ground water collected in the trenches would be piped to the two-stage treatment system described previously for leachate treatment.

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FIGURE 3
RECOMMENDED ALTERNATIVE
ECC NORTH-SOUTH CROSS SECTION

- o Special wells could be installed at the Enviro-Chem site to pull air through the contaminated soil, drawing the contaminants out of the soil (a process known as "vapor extraction"). The contaminated air would then be treated in a carbon adsorption system to remove the contaminants. Soil vapor extraction removes the contaminants from the soil so that they will not wash down into the ground water or otherwise move off the site if the site is disturbed in the future.
- o Soil at the Enviro-Chem site could be incinerated. The contaminated soil would be excavated and burned in an incinerator at the site. Incineration destroys the organic compounds in the soil. The ashes resulting from the burning would be placed back on the site before the site is capped.
- o Contaminated sludge in the former cooling pond at the Enviro-Chem site could be excavated and disposed of at a licensed disposal facility.
- o A lined "RCRA landfill" meeting federal standards could be constructed on the northern part of the Northside site. Contaminated soils would be temporarily removed and stored during construction of the landfill. The contaminated soil would then

A021572

be put back into the landfill and the site would be capped. The lined landfill would block the escape of contaminants from the site into the soil or ground water.

- o In addition to the measures described above, U.S. EPA could monitor the ground water and surface water around the two sites to ensure that the actions taken are effective.

REMEDIAL ALTERNATIVES EVALUATED BY U.S. EPA

For the Combined Alternatives Analysis, U.S. EPA evaluated nine different combinations of the measures described previously. These combinations, known as remedial alternatives (see glossary), and their respective costs are compared in Figure 4. Alternative 1 is the "No Action" alternative that U.S. EPA is required by federal law to consider. The alternatives shown in Figure 4 combine as many as nine of the measures described in the previous section. Not all of the measures listed in the previous section are necessary to define an alternative because some of them accomplish similar objectives.

U.S. EPA compared each of the nine alternatives shown in Figure 4 on the basis of technical feasibility, reliability, effectiveness in protecting public health and welfare and the environment, cost, and

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Remedial Alternatives

| Remedial Measures | | ALTERNATIVE 1 NO ACTION | ALTERNATIVE 2 | ALTERNATIVE 3 | ALTERNATIVE 4 | ALTERNATIVE 5 RECOMMENDED ALTERNATIVE | ALTERNATIVE 6 | ALTERNATIVE 7 | ALTERNATIVE 8 | ALTERNATIVE 9 |
|------------------------------------|------------|----------------------------|---------------|---------------|---------------|--|---------------|---------------|---------------|---------------|
| DEED AND ACCESS RESTRICTIONS | | | X | X | X | X | X | X | X | X |
| SITE COVER | • SOIL CAP | | X | | X | | | | | |
| | • RCRA CAP | | | X | | X | X | X | X | X |
| SEDIMENT REMOVAL | | | X | X | X | X | X | X | X | X |
| REROUTING UNNAMED DITCH | | | X | X | X | X | X | X | X | X |
| LEACHATE COLLECTION AND TREATMENT | | | X | X | X | X | X | X | X | X |
| GROUNDWATER INTERCEPTION/TREATMENT | | | | | X | X | | | | |
| GROUNDWATER ISOLATION/TREATMENT | | | | | | | X | X | X | |
| SOIL VAPOR EXTRACTION | | | | | | | | X | | |
| SOIL INCINERATION | | | | | | | | | X | |
| RCRA LANDFILL | | | | | | | | | | X |
| MONITORING | | | X | X | X | X | X | X | X | X |
| COOLING POND SLUDGE REMOVAL | | | | X | X | X | X | X | X | X |
| COST (\$ MILLIONS)* | | 0 | 18.1 | 29.9 | 20.8 | 33.9 | 37.3 | 39.3 | 76.1 | 108.0 |

* All costs in present worth values

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FIGURE 4
REMEDIAL ALTERNATIVE MATRIX

several other criteria. In October 1986, U.S. EPA determined that Alternative 5 (highlighted in Figure 4) effectively protects public health and welfare and the environment at the least cost. Therefore, U.S. EPA is recommending that the measures included in this alternative be carried out at the Northside and Enviro-Chem sites. Figure 5 shows a top view of the Northside and Enviro-Chem sites and highlights the locations of the remedial measures recommended by U.S. EPA in Alternative 5.

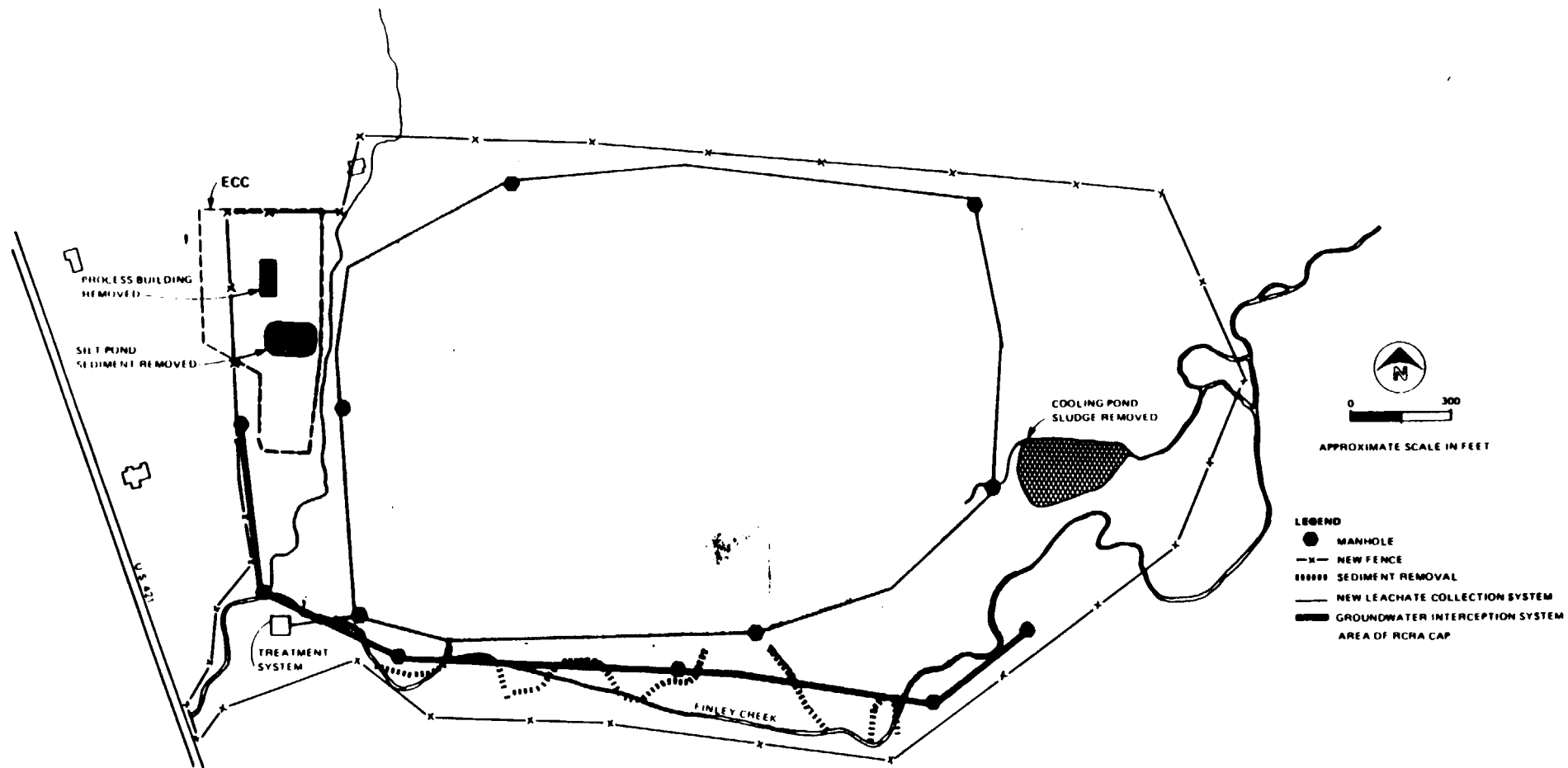


FIGURE 6
TOP VIEW OF U.S. EPA'S
RECOMMENDED ALTERNATIVE

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OPPORTUNITIES FOR PUBLIC INVOLVEMENT

Public Meeting on the Feasibility Studies and Combined Alternatives Analysis for the Northside and Enviro-Chem Sites

U.S. EPA will hold a public meeting to present the findings of the Feasibility Studies and the Combined Alternatives Analysis for Northside and Enviro-Chem and to respond to questions and comments from the public about these documents and U.S. EPA's recommended alternative for the sites.

DATE: December 10, 1986

TIME: 7 p.m.

LOCATION: Zionsville Town Hall
110 South 4th Street
Zionsville, Indiana

**Public Comment Period on the Feasibility Studies and the Combined
Alternatives Analysis for the Northside and Enviro-Chem Sites**

U.S. EPA encourages the public to review the Feasibility Studies and the Combined Alternatives Analysis and to submit written comments. You can find copies of these documents and other site-related information in Zionsville at the Town Hall at 110 South 4th Street and at the Hussey Memorial Library at 225 West Hawthorne Street. Copies are also available from the U.S. EPA Region V office at the address listed below. Comments must be postmarked by January 24 1987. Send comments to:

Art Gasior
Community Relations Coordinator
U.S. Environmental Protection Agency
230 South Dearborn Street
Chicago, Illinois 60604

IF YOU HAVE QUESTIONS about this fact sheet or the Feasibility Studies and Combined Alternatives Analysis reports for the Northside and Enviro-Chem sites, or if you would like to request copies of these documents, contact:

Art Gasior (312) 886-6128
Community Relations Coordinator

Karen Vendl

(312) 886-4739

Remedial Project Manager

Hazardous Waste Enforcement Branch

U.S. Environmental Protection Agency

230 South Dearborn Street

Chicago, Illinois 60604

TOLL FREE: (800) 621-8431

8:30 a.m. to 4:30 p.m. Central Time

-----END OF BOX-----

-----BOX (BACK PAGE)-----

MAILING LIST ADDITIONS

If you are not already on U.S. EPA's mailing list for the NSL and ECC sites, please fill out the following information and send this form to:

Art Gasior
Community Relations Coordinator
U.S. EPA
230 South Dearborn Street
Chicago, IL 60604

Name_____

Affiliation_____

Address_____

Phone:_____

-----END OF BOX-----

GLOSSARY

| | |
|----------------------------------|---|
| Ground Water | Water beneath the Earth's surface that fills pores between soil, sand, and gravel particles to the point of saturation. Ground water generally flows through zones of rock or soil (at rates much slower than surface water) and when it occurs in sufficient quantity, it can be used as a water supply. |
| Inorganic Chemicals or Compounds | Inorganic chemicals or compounds are composed of mineral materials, including elemental salts and metals such as iron, aluminum, mercury, and zinc. |
| Leachate | Leachate is not a specific chemical itself; it is a liquid, often water, that has seeped through wastes and picked up components of those wastes. |
| Organic Chemicals or Compounds | Chemicals composed mainly of carbon, including materials such as solvents, oils, and pesticides. |

**Present Worth
Cost**

Putting the costs of a project in "present worth" terms allows U.S. EPA to compare projects that require expenditures over different periods of time. The present worth cost of a project is less than the sum total of all actual expenditures for the project, because to have a dollar a year from now, some lesser amount can be invested now to earn interest, yielding a dollar in one year. The present worth of next year's dollar is that lesser amount. Thus, the actual number of dollars that would be spent on U.S. EPA's recommended alternative, for example, would be greater than \$33.9 million, but \$33.9 million is the present worth cost of the alternative. The interest rate U.S. EPA used to calculate present worth cost in the Feasibility Studies and the Combined Alternatives Analysis is ten percent.

RCRA

The Resource Conservation and Recovery Act (RCRA) is a federal law passed in 1976 and amended in 1984 regulating the transportation, treatment, storage, and disposal of hazardous waste. A "RCRA cap" (or "RCRA landfill") is a multiple-layer cap (or landfill) that conforms to the regulations issued under this law.

| | |
|--|---|
| Remedial Alternative | <p>A method or combination of methods designed to protect public health and welfare and the environment over the long term from releases of hazardous substances at a Superfund site. Remedial alternatives are usually projects or a combination of technologies that contain, remove, or destroy most of the contaminants in the air, water, soil, and/or ground water at a Superfund site.</p> |
| Remedial Investigation/ Feasibility Study (RI/FS) | <p>The RI/FS is a two-part study which is completed before the long-term cleanup can begin. The first part is the Remedial Investigation (RI) which examines the nature and extent of contamination problems at the site. The second part is the Feasibility Study (FS), which evaluates different remedial alternatives for site cleanup and recommends the most cost-effective alternative.</p> |
| Sediment | <p>A mineral or organic substance deposited by air, water, or ice. For example, sediments settle out of creeks onto the creek bed.</p> |

Sludge A term that describes a thickened solid/liquid waste byproduct of an industrial, recycling, or treatment process.

Solvent A substance that can dissolve another substance to form a solution. Industrial solvents are used in industrial cleaners, paints, and pharmaceuticals. Many solvents are flammable and toxic, to varying degrees.

Toxic A chemical is toxic if it damages living tissue, impairs the central nervous system, or causes birth defects, illness, or death when eaten, drunk, inhaled, or absorbed through the skin.

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SUBJECT TO REVISION

Figure I missing

MONITORING WELL
SAMPLING REPORT
PHASE I - TASK 14
NORTHSIDE SANITARY LANDFILL
REMEDIAL INVESTIGATION
TDD R05-8402-02A
IN0115

PREPARED BY: S.L. SROONIAN
APRIL 25, 1984

A021539

10-1-11-11
SUBJECT TO REVIEW

M E M O R A N D U M

DATE: June 24, 1985
TO: Randy Weltzin, CH2M HILL/SPM
Karen Vendl, U.S. EPA/RSP0
FROM: Sandra L. Sroonian, Ecology and Environment, Inc./RIPM
SUBJECT: Northside Sanitary Landfill Remedial Investigation
Monitoring Well Sampling, Phase I - Task 4
Work Assignment No. 95-5LH2.0
E & E, Inc. TDD No. R55-8402-02A/IN0115

INTRODUCTION

This document is a groundwater sampling technical memorandum (TM) for the Northside Sanitary Landfill (NSL) in Northfield, Indiana. This work was performed to partially satisfy Task 14 of the Remedial Investigation/Feasibility Study (RI/FS) authorized by the U.S. Environmental Protection Agency (EPA), Work Assignment Number 95-5LH2.0 of Contract Number 68-01-6692. The primary purpose of the TM is to provide documentation of the activities that occurred during sampling and the data obtained.

PROBLEM STATEMENT

The Northside Sanitary Landfill is an active solid waste disposal facility occupying approximately one-hundred and sixty-eight (168) acres. Municipal and industrial refuse and hazardous wastes have been disposed at NSL since approximately 1940. A former chemical recycling facility named Environmental Chemical and Conservation Corp. (ECC) is located at the northwest corner of NSL. Both facilities are privately owned by the same person. The two sites are separated geographically by an unnamed ditch that flows south to its confluence with Finley Creek. Figure I is a site map depicting the subject facilities.

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DRILL
SUBJECT TO REVISION

Between 1979 and 1983, numerous groundwater samples have been collected from seven (7) monitoring wells (MW1 through MW7) along the perimeter of NSL. (See Figure 1). Analytical results for groundwater samples from these wells is limited and complete organic and inorganic priority pollutant analyses were not performed on any of the samples. ^{about 70% organic only} methylene chloride, 1,1-dichloroethylene, trichloroethylene and tetrachloroethylene were detected in monitoring well MW1 and MW2 at levels above EPA water quality criteria.^a Other organic pollutants reported at levels above the detection limit in MW1 and MW2 are: toluene, 1,1-dichloroethane, ethyl benzene, methyl ethyl ketone, 1,2-dichloroethane, 1,3-trans- dichloropropene, and 1,3-cis-dichloropropene. Phenol was also detected in MW1 through MW5. The inorganics lead^a, mercury^a, and nickel^b were found in most of the wells in concentrations exceeding EPA criteria. For additional background information on site history and analytical results, reference the NSL RI/FS Final Work Plan.

PURPOSE

The monitoring well sampling effort will provide groundwater quality data that will help define the vertical and horizontal extent and magnitudes of contaminant within the aquifers. This data will provide information necessary to evaluate the level of endangerment to human health and the environment posed by NSL. This assessment will therefore provide a basis to differentiate among alternatives in selecting recommended remedial measures.

ACTIVITIES

From February 18 through February 21 and April 25, 1985, twenty-nine (29) groundwater samples were collected from twenty-two (22) new and existing monitoring wells at NSL by E & E, Inc. personnel. Team members consisted of S.L. Sroonian, M. Pearce, T. Pachowicz,

a - carcinogenicity criteria at the 10⁻⁵ risk level

b - toxicity criteria

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T. Bahnick, C. Nolan, P. Petrella, A. Pratl, and M. Lunsford. On February 18th and 19th, R.K. Weltzin and J. Keiser of CH2M Hill were at the site surveying the elevations of the outer well casings. S.L. Sroonian and M. Pearce were at NSL April 15, 1985 to sample two wells, MW8D and MW8S. They were redrilled and reinstalled two weeks prior, due to the uncertainty of the integrity of the original wells. John Buck from the Indiana State Board of Health was present throughout both sampling efforts to observe the field activities.

Prior to sampling, each well was monitored with the Organic Vapor Analyzer (OVA) to determine the level of respiratory protection to be utilized by the sampling team. OVA readings indicated Level "C" protection was needed at fourteen (14) of the monitoring wells and Level "D" at the remaining eight (8) wells. Water level measurements were taken from Soil/Piezometer Boring (SPB) 65, SPB77, seven (7) existing monitoring wells and fourteen (14) new monitoring wells. Figure 1 is the site map which indicates the well location.

SAMPLE COLLECTION

After water level measurements were taken at each well, the volume of water stored in each casing was calculated and a volume of water equal to at least five times the well's volume was purged from each well prior to sample collection. Wells without sufficient flow were bailed dry and allowed to recharge before sample collection. See Table I for the water levels and the minimum volume of water purged from each well. Purge water from each well was contained in a fifty-five (55) gallon steel drum and left on-site.

Dedicated stainless steel cables and bailers with check valves that utilize a teflon ball were used to purge the wells and collect the groundwater samples. Each bailer was inscribed with an identification number and assigned to a specific well. The bailers were washed

A021542

with an Alconox and tap water solution, rinsed with acetone and distilled water and allowed to air dry prior to their initial use. Plastic sheeting was placed around each well location to provide a clean working space. Samples were collected by filling the sample bottles from the bailers.

All samples were collected, preserved, packaged, and shipped to the laboratories according to the U.S. EPA Contract Lab Program (CLP) criteria for low concentration water samples. Table II is a list of bottles, preservatives, packaging protocol and the method of shipment used. The metal fractions of the inorganic samples were filtered in the field before the addition of nitric acid. In addition, an eight (8) ounce glass jar was filled with water from each monitoring well and analyzed in the field for temperature, pH, and conductivity.

Twenty-nine (29) samples were collected from twenty-two (22) monitoring wells and are identified in Table II. Well number NSL 10S and SPB 77 were bailed dry therefore only the organic and metal fractions of the inorganic analytical results will be available for monitoring well NSL 10S. Three (3) duplicates and three (3) blank water samples were submitted. Duplicate samples were collected at MW1, MW6, and MW7. The field blank samples were identified as NSL-GW02-01, NSL-GW023-01 and NSL-GW024-01 respectively. A matrix spike duplicate was also collected for the analyses of organics at well number NSL 11D and identified as NSL-GW011D-01.

SAMPLE PARAMETERS

All samples collected were shipped to a CLP facility for analysis. Samples are being analyzed for the Hazardous Substance List Organics and Inorganics with the exception of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). In addition, all samples will be analyzed for cyanide, oil and grease, chloride, sulfate, alkalinity and total

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dissolved solids. Table III is a listing of compounds and parameters which will be analyzed. Water samples were analyzed for temperature, pH, and conductivity in the field.

DOCUMENTATION

A bound field notebook was used by S.L. Sroonian and sample data sheets by T. Pachowicz to record data and the activities that took place during the sampling investigation. The notebook data includes times, dates, personnel, field conditions and documentation of all particulars regarding the sample collection procedures. Photographs of the samples were taken relative to each well location. A data sheet was placed in the field of view during the taking of a photograph which identified the sample number along with the data and time the sample was collected.

SAMPLE RESULTS

Sample results from the CLP facilities are not included in this TM because the data packages have not been received from the Central Regional Laboratory. Water samples were analyzed for temperature, pH and conductivity in the field. These results are listed in Table IV - Groundwater Field Data Results.

Samples collected in February were sent to Versar, Inc. in Virginia for analyses of Hazardous Substance List Inorganics, cyanide and the parameters oil and grease, total dissolved solids, chloride, sulfate and total alkalinity. Samples analyzed for the Hazardous Substance List Organics were sent to S-Cube (S³) in California. Samples collected in April were sent to Rocky Mountain Analytical Laboratory (RMAL) in Colorado for the inorganics, organics, cyanide and the parameters oil and grease, total dissolved solids, chloride, sulfate and total alkalinity.

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TABLE I
WATER LEVELS AND VOLUMES PURGED
NORTHSIDE SANITARY LANDFILL

| <u>Well Number</u> | <u>Date</u> | <u>Ground Elevation (Feet)</u> | <u>Water Level (Feet)</u> | <u>Water Volume (Gallons)</u> | <u>Volume Purged (Gallons)</u> |
|---------------------------|-------------|--|-----------------------------------|---------------------------------------|--|
| 4 inch inside diameter | | | | | |
| MW1 | 2/19/85 | 876.07 | 872.40 | 3.48 | 17.5 |
| MW2 | 2/19/85 | 876.95 | 873.45 | 16.65 | 83.5 |
| MW3 | 2/19/85 | 885.19 | 877.62 | 7.46 | 37.5 |
| MW4 | 2/19/85 | 884.63 | 883.79 | 23.60 | 118 |
| MW5 | 2/19/85 | 886.90 | 883.72 | 10.98 | 55 |
| MW6 | 2/19/85 | 916.56 | 903.41 | 20.79 | 104 |
| MW7 | 2/19/85 | 970.83 | 899.71 | 14.28 | 71.5 |
| 2 inch inside diameter | | | | | |
| NSL8SA | 4/15/85 | 881.44 | 875.66 | 2.07 | 10.5 |
| NSL8DA | 4/15/85 | 881.05 | 883.59 | 6.86 | 34.5 |
| NSL9S | 2/19/85 | 887.23 | 878.86 | 1.08 | 5.5 |
| NSL9D | 2/19/85 | 887.04 | 878.17 | 2.96 | 15 |
| NSL10S | 2/19/85 | 885.28 | 881.75 | 0.89 | 5 ^a |
| NSL10D | 2/19/85 | 885.26 | 882.21 | 4.89 | 24.5 |
| NSL11S | 2/19/85 | 897.56 | 895.12 | 0.66 | 3.5 ^a |
| NSL11D | 2/19/85 | 897.57 | 895.21 | 5.44 | 27.5 |
| NSL12 | 2/19/85 | 873.59 | 871.56 | 3.42 | 17.5 |
| NSL13 | 2/19/85 | 876.05 | 872.30 | 1.59 | 8 |
| NSL14 | 2/19/85 | 877.24 | 873.86 | 0.92 | 5 |
| NSL15 | 2/19/85 | 885.65 | 882.63 | 0.57 | 3 |
| NSL16 | 2/19/85 | 911.90 | 907.35 | 1.22 | 6.5 |
| NSL18 | 2/19/85 | 886.46 | 882.52 | 1.48 | 7.5 |
| SPB65 | 2/19/85 | 876.00 | 871.20 | 2.48 | 12.5 |
| SPB77 | 2/19/85 | 892.34 | 882.17 | 2.99 | 15 ^b |
| SPB77 | 4/15/85 | 892.34 | 883.56 | 3.22 | 16.5 ^c |

a - slow recharge

b - eleven gallons purged, well went dry, no sample collected.

c - fifteen gallons purged, well went dry, no sample collected.

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TABLE II
BOTTLES, PRESERVATION, SHIPPING AND PACKING REQUIREMENTS

| <u>Analysis</u> | <u>Bottles and Jars</u> | <u>Preservation</u> | <u>Holding Time</u> | <u>Volume of Sample</u> | <u>Shipping</u> | <u>Packaging</u> |
|---|--|--|-------------------------|--------------------------------|----------------------------|------------------|
| <u>WATER AND LIQUIDS</u> | | | | | | |
| <u>Low Concentration (Organics)</u> | | | | | | |
| Acid extractables, base/neutral extractables, pesticides/PCB's | One 1 - gallon glass amber bottle (teflon-lined caps) | Iced to 4°C | 2 days until extraction | Fill bottle to neck | Federal Express Priority 1 | Vermiculite |
| Volatiles | Two 40-ml volatile organic analysis (VOA) vials | Iced to 4 °C | 7 days | Fill completely no air bubbles | Federal Express Priority 1 | Vermiculite |
| <u>Low Concentration (Inorganics)</u> | | | | | | |
| Tasks 1 & 2 | One 1-liter high density polyethylene bottle | HNO ₃ to pH <2, Iced to 4°C | 6 months | Fill to shoulder of bottle | Federal Express Priority 1 | Vermiculite |
| Task 3 | | | | | | |
| Cyanide | One 1-liter polyethylene bottle | NaOH to pH >12, Iced to 4°C | 14 days | Fill to shoulder of bottle | Federal Express Priority 1 | Vermiculite |
| Sulfate | One 1-liter high density polyethylene bottle | Iced to 4°C | | Fill to shoulder of bottle | Federal Express Priority 1 | Vermiculite |
| TDS, Chloride, Alkalinity Calcium, Magnesium, Potassium, Sodium | One 1-liter high density polyethylene bottle | Iced to 4°C | | Fill to shoulder of bottle | Federal Express Priority 1 | Vermiculite |
| Oil and Grease | One 32-ounce wide mouth glass bottle - aluminum foil under cap | 5 ml of H ₂ SO ₄ | 28 days | Fill to shoulder of bottle | Federal Express Priority 1 | Vermiculite |

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SUBJECT

TABLE II (Continued)

| <u>Analysis</u> | <u>Bottles and Jars</u> | <u>Preservation</u> | <u>Holding Time</u> | <u>Volume of Sample</u> | <u>Shipping</u> | <u>Packaging</u> |
|--|-------------------------------|---------------------|---------------------|------------------------------|----------------------------|------------------|
| SOILS AND SOLIDS | | | | | | |
| <u>Low Concentration (Organics)</u> | | | | | | |
| Acid extractables, base/neutral extractables, pesticides/PCB's | One 8-oz wide mouth glass jar | Iced to 4°C | Not established | Fill 3/4 full | Federal Express Priority 1 | Vermiculite |
| Volatiles | Six 40-ml VOA vials | Iced to 4°C | Not established | Fill completely no headspace | Federal Express Priority 1 | Vermiculite |
| <u>Low Concentration (Inorganics)</u> | | | | | | |
| Metals, cyanide | One 8-oz wide mouth glass jar | Iced to 4°C | Not established | Fill 3/4 full | Federal Express Priority 1 | Vermiculite |
| Oil and Grease | One 8-oz wide mouth glass jar | Iced to 4°C | Not established | Fill 3/4 full | Federal Express Priority 1 | Vermiculite |

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 SUBJECT

TABLE III (PAGE 1 OF 3)
ORGANIC AND INORGANIC CONSTITUENTS TO BE ANALYZED FOR
HAZARDOUS SUBSTANCE LIST ORGANICS

DRAFT
SUBJECT 10

ACID COMPOUNDS

| CAS # | |
|----------|----------------------------|
| 88-06-2 | 2,4,6-trichlorophenol |
| 59-50-7 | p-chloro-m-cresol |
| 95-57-8 | 2-chlorophenol |
| 120-83-2 | 2,4-dichlorophenol |
| 105-67-9 | 2,4-dimethylphenol |
| 88-75-5 | 2-nitrophenol |
| 100-02-7 | 4-nitrophenol |
| 51-28-5 | 2,4-dinitrophenol |
| 534-52-1 | 4,6-dinitro-2-methylphenol |
| 87-86-5 | pentachlorophenol |
| 108-95-2 | phenol |
| 65-85-0 | benzoic acid |
| 95-48-7 | 2-methylphenol |
| 108-39-4 | 4-methylphenol |
| 95-95-4 | 2,4,5-trichlorophenol |

PESTICIDES

| CAS # | |
|------------|-------------------------|
| 309-00-2 | aldrin |
| 60-57-1 | dieldrin |
| 57-74-9 | chlordan |
| 50-29-3 | 4,4'-DDT |
| 72-55-9 | 4,4'-DDE |
| 72-54-8 | 4,4'-DDD |
| 115-29-7 | α -endosulfan |
| 115-29-7 | β -endosulfan |
| 1031-07-8 | endosulfan sulfate |
| 72-20-8 | endrin |
| 7421-93-4 | endrin aldehyde |
| 76-44-8 | heptachlor |
| 1024-57-3 | heptachlor epoxide |
| 319-84-6 | α -BHC |
| 319-85-7 | β -BHC |
| 319-86-8 | δ -BHC |
| 58-89-9 | γ -BHC (lindane) |
| 53469-21-9 | PCB-1242 |
| 11097-69-1 | PCB-1254 |
| 11104-28-2 | PCB-1221 |
| 11141-16-5 | PCB-1232 |
| 12672-29-6 | PCB-1248 |
| 11096-82-5 | PCB-1260 |
| 12674-11-2 | PCB-1016 |
| 8001-35-2 | toxaphene |

BASE/NEUTRAL COMPOUNDS

| CAS # | |
|------------|-----------------------------|
| 83-32-9 | acenaphthene |
| 92-87-5 | benzidine |
| 120-82-1 | 1,2,4-trichlorobenzene |
| 118-74-1 | hexachlorobenzene |
| 67-72-1 | hexachloroethane |
| 111-44-4 | bis(2-chloroethyl)ether |
| 91-58-7 | 2-chloronaphthalene |
| 95-50-1 | 1,2-dichlorobenzene |
| 541-73-1 | 1,3-dichlorobenzene |
| 106-46-7 | 1,4-dichlorobenzene |
| 91-94-1 | 3,3'-dichlorobenzidine |
| 121-14-2 | 2,4-dinitrotoluene |
| 606-20-2 | 2,6-dinitrotoluene |
| 122-66-7 | 1,2-diphenylhydrazine |
| 206-44-0 | fluoranthene |
| 7005-72-3 | 4-chlorophenyl phenyl ether |
| 101-55-3 | 4-bromophenyl phenyl ether |
| 39638-32-9 | bis(2-chloroisopropyl)ether |
| 111-91-1 | bis(2-chloroethoxy)methane |
| 87-68-3 | hexachlorobutadiene |
| 77-47-4 | hexachlorocyclopentadiene |
| 78-59-1 | isophorone |
| 91-20-3 | naphthalene |
| 98-95-3 | nitrobenzene |
| 86-30-6 | N-nitrosodiphenylamine |
| 621-64-7 | N-Nitrosodipropylamine |
| 117-81-7 | bis(2-ethylhexyl)phthalate |
| 85-68-7 | benzyl butyl phthalate |
| 84-74-2 | di-n-butyl phthalate |
| 117-84-0 | di-n-octyl phthalate |
| 84-66-2 | diethyl phthalate |
| 131-11-3 | dimethyl phthalate |
| 56-55-3 | benzo(a)anthracene |
| 62-53-3 | aniline |
| 100-51-6 | benzyl alcohol |
| 106-47-8 | 4-chloroaniline |
| 132-64-9 | dibenzofuran |
| 91-57-6 | 2-methylnaphthalene |
| 88-74-4 | 2-nitroaniline |
| 99-09-2 | 3-nitroaniline |
| 100-01-6 | 4-nitroaniline |
| 50-32-8 | benzo(a)pyrene |
| 205-99-2 | benzo(b)fluoranthene |
| 207-08-9 | benzo(k)fluoranthene |
| 218-01-9 | chrysene |
| 208-96-8 | acenaphthylene |
| 120-12-7 | anthracene |
| 191-24-2 | benzo(ghi)perylene |
| 86-73-7 | fluorene |
| 85-01-8 | phenanthrene |
| 53-70-3 | dibenzo(a,b)anthracene |
| 193-39-5 | indeno(1,2,3-cd)pyrene |
| 129-00-0 | pyrene |

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TABLE III (PAGE 2 OF 3)

DR
SUBVOLATILES

| <u>CAS #</u> | |
|--------------|---------------------------|
| 107-02-8 | acrolein |
| 107-13-1 | acrylonitrile |
| 71-43-2 | benzene |
| 56-23-5 | carbon tetrachloride |
| 108-90-7 | chlorobenzene |
| 107-06-2 | 1,2-dichloroethane |
| 71-55-6 | 1,1,1-trichloroethane |
| 75-34-3 | 1,1-dichloroethane |
| 79-00-5 | 1,1,2-trichloroethane |
| 79-34-5 | 1,1,2,2-tetrachloroethane |
| 75-00-3 | chloroethane |
| 110-75-8 | 2-chloroethylvinyl ether |
| 67-66-3 | chloroform |
| 75-35-4 | 1,1-dichloroethene |
| 156-60-5 | trans-1,2-dichloroethene |
| 78-87-5 | 1,2-dichloropropane |
| 10061-02-6 | trans-1,3-dichloropropene |
| 10061-01-05 | cis-1,3-dichloropropene |
| 100-41-4 | ethylbenzene |
| 75-09-2 | methylene chloride |
| 74-87-3 | chloromethane |
| 74-83-9 | bromomethane |
| 75-25-2 | bromoform |
| 75-27-4 | bromodichloromethane |
| 75-69-4 | fluorotrichloromethane |
| 75-71-8 | dichlorodifluoromethane |
| 124-48-1 | chloroethylbromomethane |
| 127-18-4 | tetrachloroethene |
| 108-88-3 | toluene |
| 79-01-6 | trichloroethene |
| 73-01-4 | vinyl chloride |
| 67-64-1 | acetone |
| 78-93-3 | 2-butanone |
| 75-15-0 | carbonyl disulfide |
| 519-78-6 | 2-hexanone |
| 108-10-1 | 4-methyl-2-pentanone |
| 100-42-5 | styrene |
| 108-05-4 | vinyl acetate |
| 95-47-6 | o-xylene |

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Hazardous Substance List Inorganics

DERIVED
SUBJECT

Aluminum

Antimony

Arsenic

Barium

Beryllium

Cadmium

Chromium

Cobalt

Copper

Iron

Lead

Magnesium

Manganese

Mercury

Nickel

Potassium

Selenium

Silver

Sodium

Thallium

Tin

Vanadium

Zinc

Total Cyanides

Miscellaneous

Oil and Grease

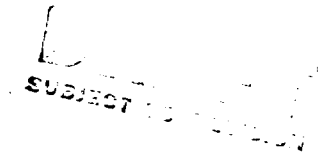
Chloride

Sulfate

Alkalinity, total

Total Dissolved Solids

A021550



 SUBJECT:

TABLE IV (Page 1 of 2)

GROUNDWATER FIELD DATA RESULTS
NORTHSIDE SANITARY LANDFILL

| Sample Number | Well Number | Date Sampled | Time of Collection | Date Shipped | Bailer Number | Temperature | | pH | Conductivity umho |
|------------------------------|----------------|--|-----------------------|-----------------|------------------|-------------|------|------|----------------------|
| | | | | | | 1 | 2 | | |
| NSL-GW001-01 | MW1 | 2/20/85 | 0950 | 2/20/85 | 465609 | 8°C | 10°C | 6.90 | 3260 |
| NSL-GW002-01 | MW2 | 2/20/85 | 1048 | 2/20/85 | 465611 | 6°C | 9°C | 7.59 | 485 |
| NSL-GW003-01 | MW3 | 2/20/85 | 1100 | 2/20/85 | 465697 | 9°C | 9°C | 7.67 | 454 |
| NSL-GW004-01 | MW4 | 2/20/85 | 1201 | 2/20/85 | 465607 | 8°C | 9°C | 7.63 | 453 |
| NSL-GW005-01 | MW5 | 2/20/85 | 1250 | 2/20/85 | 465608 | 9°C | 9°C | 7.34 | 580 |
| NSL-GW006-01 | MW6 | 2/20/85 | 1340 | 2/20/85 | 465600 | 11°C | 10°C | 7.21 | 532 |
| NSL-GW007-01 | MW7 | 2/20/85 | 1445 | 2/20/85 | 465605 | 9°C | 10°C | 7.12 | 538 |
| NSL-GW008S-01 | NSL8S | 4/15/85 | 1300 | 4/15/85 | 465610 | - | 20°C | 7.75 | 52.7 |
| NSL-GW008D-01 | NSL8D | 4/15/85 | 1620 | 4/15/85 | 465596 | - | 20°C | 7.90 | 475 |
| NSL-GW009S-01 | NSL9S | 2/20/85 | 1130 | 2/20/85 | 465614 | 8°C | 10°C | 6.73 | 2630 |
| NSL-GW009D-01 | NSL9D | 2/20/85 | 1145 | 2/20/85 | 465620 | 9°C | 10°C | 7.12 | 1330 |
| NSL-GW010S-01 | NSL10S | 2/20/85 | 1727 ^a | 2/20/85 | 465612 | 7°C | Dry | | |
| NSL-GW010S-01 | NSL10S | 2/21/85 | 1230 ^b | 2/21/85 | 465612 | 7°C | Dry | | |
| NSL-GW010D-01 | NSL10D | 2/20/85 | 1215 | 2/20/85 | 465608 | 9°C | 9°C | 7.74 | 462 |
| NSL-GW011S-01 | NSL11S | 2/20/85 | 1640 ^a | 2/20/85 | 465616 | 6°C | 10°C | 7.83 | 602 |
| NSL-GW011S-01 | NSL11S | 2/20/85 | 1200 ^b | 2/21/85 | 465616 | 6°C | 10°C | 7.83 | 602 |
| NSL-GW011D-01 | NSL11D | 2/20/85 | 1700 | 2/20/85 | 465601 | 10°C | | 7.39 | 455 |
| NSL-GW011D-01 ^{a,c} | NSL11D | 2/20/85 | 1700 | 2/20/85 | 465601 | 10°C | 9°C | 7.39 | 455 |
| NSL-GW0102-01 | NSL12 | 2/20/85 | 0955 | 2/20/85 | 465618 | 8°C | | 7.19 | 3140 |
| NSL-GW013-01 | NSL13 | 2/20/85 | 1930 | 2/20/85 | 465603 | 5°C | 9°C | 6.90 | 2030 |
| NSL-GW014-01 | NSL14 | 2/20/85 | 1048 | 2/20/85 | 465598 | 5°C | 9°C | 6.70 | 4720 |
| NSL-GW015-01 | NSL15 | 2/20/85 | 1201 | 2/20/85 | 465615 | 4°C | 9°C | 7.61 | 484 |
| NSL-GW016-01 | NSL16 | 2/20/85 | 1330 | 2/20/85 | 465613 | 9°C | 10°C | 7.15 | 616 |
| NSL-GW018-01 | NSL18 | 2/20/85 | 1500 | 2/20/85 | 465617 | 8°C | 10°C | 6.54 | 1209 |
| NSL-GW019-01 ^d | MW1 | 2/20/85 | 0930 | 2/20/85 | 465609 | 8°C | 10°C | 6.95 | 3350 |
| NSL-GW020-01 ^d | MW6 | 2/20/85 | 1340 | 2/20/85 | 465605 | 7°C | 10°C | 7.25 | 539 |
| NSL-GW021-01 ^d | MW7 | 2/20/85 | 1510 | 2/20/85 | 465604 | 10°C | 10°C | 7.06 | 736 |
| NSL-GW022-01 | Blank | 2/20/85 | 1830 | 2/20/85 | 465604 | 10°C | 10°C | 5.98 | 4.4 |
| NSL-GW023-01 | Blank | 2/21/85 | 1320 | 2/20/85 | 465604 | 10°C | 10°C | 7.04 | 6.7 |
| NSL-GW024-01 | Blank | 4/15/85 | 1700 | 4/15/85 | 465604 | - | 20°C | 8.38 | 82.7 |
| NSL-GW065-01 | SPB65 | 2/20/85 | 1030 | 2/20/85 | 465599 | 8°C | 9°C | 6.77 | 4680 |
| NSL-GW077-01 | SPB77 | Well went dry - checked 2/20, 2/21, 4/15, 1985. No sample collected. | | | | | | | |

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SUBJECT

TABLE IV (Page 2 of 2)

1. Temperature of sample at time of collection
2. Temperature of sample when pH and conductivity readings were taken.
 - a. Organics only
 - b. Inorganics only
 - c. Matrix spike duplicate
 - d. Duplicate sample

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Chapter 5

CONTAMINANT MIGRATION AND FATE

INTRODUCTION

This chapter is divided into two sections: general discussion of the present and potential pathways of contaminant migration in terms of the possible receptors; and a discussion of the migration and fate of contaminants at the ^{NSL} ECC-site. Due to the large number of contaminants found onsite, specific indicator chemicals were chosen as representative of the range of contaminants based on concentration, migration potential, degradation rates, toxicity, and carcinogenicity. The indicator chemicals chosen are listed in Table 5-1.

POTENTIAL PATHWAYS OF MIGRATION

CONTAMINANT SOURCE

The source of contamination at the NSL site is an unknown quantity of hazardous materials which were dumped on the landfill. It is not known if any of the materials have been removed or if they are still present in the landfill.

Original

in the hazardous waste site of the NSL site.

A021482

Table 5-1
INDICATOR CHEMICALS AT ECC

Chloroform
Methylene Chloride
~~1,1,2-Trichloroethane (1,1,2-TCA)~~
1,1,1-Trichloroethane (1,1,1 TCA)
Trichloroethene (TCE)
Tetrachloroethene (PCE)
Ethylbenzene
Toluene
Phenol
PCB's
Bis(2-ethylhexyl)phthalate
Di-n-butyl phthalate
Diethyl phthalate
Dimethyl-phthalate

GLT301/58

A021483

INSECT "A"

Soil samples taken from the landfill

surface indicated that the

contaminants were only present in

these portions of soil. Samples

~~could~~^{were} not ~~be~~ taken closer to

landfill due to space

Soil samples taken from the landfill

area of 11. to 8.14 indicated

contaminants were not present.

PATHWAYS

Figure 5-1 illustrates the potential pathways for contaminant migration.

Onsite Soils

Although the ~~ECC~~^{DBL} site was covered with a clay cap upon completion of surface cleanup activities, samples from ponding surface water indicated the presence of organics. Though soil samples of the cap were not analyzed, it is presumed they are contaminated with the organics detected in the ponding surface water samples. These contaminants could volatilize or be transported as dust particles entrained by wind or transported in surface water runoff. Below the cap, heavily contaminated soil could be a risk to receptor populations since any future excavation might bring contaminants to the surface. Once chemicals are at the surface, receptors (plants and wildlife, as well as humans) may be subject to inhalation, ingestion and direct contact of harmful compounds.

Leaching is probably the most significant
Transport of contaminants from onsite soils is also likely through leaching. As water infiltrates through the contaminated soil, ^{and debris} it will desorb many compounds and eventually leach into the groundwater ^{within the} in the shallow saturated zone. This is presently the case as the

glacial till aquifer
groundwater samples from the shallow-saturated-zone were
found to be contaminated with volatile organics. *leachate*
is also seeping from the side slopes of the
land fill and ~~directly~~ discharging to the unnamed
Groundwater *data on Future work.*

Once contaminants have entered the groundwater, several
pathways of migration are possible. As mentioned previously
in this report, four hydrologic units are located under the
ECC site. In the past, contaminants could potentially
migrate downwards from the shallow-saturated-zone and
contaminate the lower sand and gravel aquifer. Low level
contamination found in the shallow sand and gravel aquifer
onsite indicates that this probably has occurred.
Alteration of site characteristics during surface cleanup,
however, has made this an unlikely migration pathway
presently or in the future. The cooling pond, which was
hydrologically connected to the shallow sand and gravel
aquifer, has been cleaned of contaminated water and
sediments, and backfilled with clean fill material. Onsite
ponding water has also been removed, thus eliminating the
downward vertical gradient. Water can no longer pond
onsite, and vertical gradients between the shallow saturated
zone and the shallow sand and gravel aquifer are upward.
However, future excavation at the site could cause ponding
of water onsite and reverse the gradient and enable downward
migration of contaminants into the shallow sand and gravel
aquifer.

Evidence of downward migration of contaminants from the shallow sand and gravel to the deep confined aquifer was not found and is highly unlikely now or in the future due to the upward vertical gradient. Existing low level contaminants in the shallow sand and gravel aquifer will likely migrate ~~south~~ and discharge to the unnamed ditch or Finley Creek. Receptors could potentially contact the groundwater if potable wells are constructed within the zones of contamination.

In summary, the most probable pathways for contaminant transport in the groundwater are through migration from the ~~shallow saturated zone~~ ^{from the surface} or from the shallow sand and gravel aquifer to the unnamed ditch or Finley Creek.

Surface Waters

Both the unnamed ditch and Finley Creek receive groundwater and surface water runoff from the ^{USE} ECC site. Contaminants in the surface water may volatilize, precipitate or adsorb in sediments, or remain in solution and be transported downstream to Big Eagle Creek and eventually the Eagle Creek Reservoir. Receptors may be exposed by wading in the creek, ingesting contaminated water, or ingesting fish which have bioaccumulated contaminants.

Sediments

Contaminants within stream sediment may dissociate and reenter solution or may be scoured and resuspended in high flow and carried downstream. During low flow periods contaminated sediments may be exposed along the stream banks and may be transported as dust.

MIGRATION AND FATE OF INDICATOR CHEMICALS

Given the nature of contamination at ~~BEC~~²¹ and the potential pathways of migration, indicator chemicals were assessed in terms of their behavior in soils, groundwater, and aquatic systems. Emphasis was placed on the mobility and persistence of each chemical. Mobility is important because it determines the rate of chemical migration away from the site. Persistence is important because it determines if a chemical will remain in the environment long enough to reach a receptor.

CHARACTERIZATION OF INDICATOR CHEMICALS

Table 5-2 lists some of the important physical-chemical properties of each indicator chemical. No inorganics were

Insert
EB
~~Table D-1 lists some of the key physical-chemical properties of each organic indicator chemical. The properties of oxazolidone are not included due to a lack of literature data. The properties of the metal indicators are not included because they are not as relevant in determining their environmental behavior. In addition, properties like solubility can vary significantly depending upon a number of factors, including pH, metal concentration, oxidation-reduction potential, soil type, and the presence of competing and complexing ions. With the exception of the data for PCB's, Callahan et al. (1979) were the source of the information in Table D-1. Mackay et al. (1983) were consulted to obtain the physical properties for PCB's. The properties in Table D-1 do not reflect any potential interactions between chemicals.~~

A021488

It is important to note that the actual migration and fate of the contaminants depend largely on the physical-chemical features of the site such as temperature, pH, percent soil moisture, geochemistry, soil type, and oxidation-reduction potential. Other factors that must be considered are potential reactions between chemicals and the formation of transformation byproducts. For example, under certain conditions ^{trichloroethene} tetrachloroethene is believed to breakdown to trichloroethene, ^cand then to the "cis" form of dichloroethene and then to vinyl chloride. Each of the byproducts are compounds that ^cwould pose a health threat to receptors. It is beyond the scope of this project to research the migration and fate of all the byproducts; however, their significance should be recognized.

⁵ Table 5-3^{10/5/77} provides a summary of the environmental behavior of the indicator organic compounds. Summaries are provided for three key sectors of the environment: subsurface soils and groundwater, surface soils, and aquatic systems. Potential transformation and transfer mechanisms are listed for each indicator chemical. Transformation mechanisms act to change the form of a chemical, while transfer mechanisms partition the chemical between media (e.g., volatilization is a water-air transfer; sorption is a water-soil transfer). The persistence of a chemical in a given sector of the environment is generally controlled by transformation mechanisms and volatilization. Chemical mobility in a given

Table 5-2
PHYSICAL-CHEMICAL PROPERTIES OF INDICATOR ORGANICS

| | Molecular Weight | Boiling Point (°C) ^a | Vapor Pressure (torr) ^b | Solubility (mg/L) | Log Kow ^c | Kd ^e |
|-------------------------------|------------------|---------------------------------|------------------------------------|------------------------|----------------------|-----------------|
| <u>Volatile Organics</u> | | | | | | |
| 1,1,2-trichloroethene | 133.41 | 133.8 | 19 ^d | 4,500 ^d | 2.17 | 0.18 |
| 1,1,1-trichloroethane | 133.41 | 74.1 | 97.0 ^d | 480-4,400 ^d | 2.17 | 0.18 |
| Tetrachloroethene | 165.83 | 121.0 | 14.0 ^d | 150-200 | 2.88 | 0.94 |
| Trichloroethene | 131.39 | 87.0 | 57.9 ^d | 1,100 | 2.29 | 0.24 |
| Toluene | 92.13 | 110.6 | 28.7 ^d | 535 ^f | 2.69 | 0.60 |
| Chloroform | 119.38 | 61.7 | 150.5 ^d | 8,200 ^d | 1.97 | 0.12 |
| Methylene chloride | 84.99 | 39.8 | 350.0 ^d | 20,000 ^d | 1.25 | 0.022 |
| Ethylbenzene | 106.2 | 136.2 | 152 ^d | 152 ^d | 3.15 | 1.74 |
| <u>Acid Compounds</u> | | | | | | |
| Phenol | 94.11 | 181.8 | 0.8 ^f | 93,000 ^f | 1.46 | 0.036 |
| <u>Base/Neutral Compounds</u> | | | | | | |
| Bis(2-ethylhexyl)phthalate | 391.0 | 386.9 | 0.01 ^d | 1.3 ^f | 8.7 | 660,000 |
| Dimethyl-phthalate | 194.2 | 202.0 | 0.01 ^d | 896 ^f | 2.12 | 0.16 |
| Diethyl phthalate | 222.2 | 298.0 | 0.05 ^h | 4,320 ^f | 3.22 | 2.05 |
| Di-n-butyl phthalate | 278.3 | 340.0 | 0.1 ^g | 13 | 5.2 | 195 |
| <u>Other Organics</u> | | | | | | |
| PCB 1260 | 375.7 | - | 4.05x10 ^{-5f} | 0.0027 | 7.14 | 17,000 |
| PCB 1232 | 332.2 | - | 4.06x10 ^{-3f} | 1.45 | 3.2 | 1.95 |

- ^a Boiling point at 760 torr.
^b torr = 1 mm of mercury (Hg).
^c Kow = octanol-water partition coefficient.
^d Vapor pressure/solubility at 20°C.
^e K_d = soil-water partition coefficient
^{f,d} Vapor pressure/solubility at 25°C.
^g Vapor pressure/solubility @ 115°C
^h Vapor pressure/solubility @ 70°C.

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Table 5-3 (Page 1 of 2)
SUMMARY OF ENVIRONMENTAL BEHAVIOR OF INDICATOR ORGANIC COMPOUNDS IN
SUBSURFACE SOILS, GROUNDWATER, SURFACE SOILS AND AQUATIC SYSTEMS

| Compound | Subsurface Soils and Groundwater | | | | Surface Soils | | | | | |
|---------------------------|----------------------------------|--------------|-------------------------|----------------|----------------|------------|----------------|-----------------------|----------------|----------------|
| | Transformation | | | Transfer | Transformation | | | | Transfer | |
| | Oxidation | Hydrolysis | Biodegradation | Sorption | Oxidation | Hydrolysis | Photolysis | Biodegradation | Volatilization | Sorption |
| 1,1,1-Trichloroethane | I | I | M | I | I | I | I | P | S | I |
| 1,1,2-Trichloroethane | I | 6 mos - 1 yr | P ^a | I | I | P | I | I | S | I |
| Tetrachloroethene | 8.8 mos | I | P ^a | I | P | I | I | I | S | I |
| Trichloroethene | 10.7 mos | I | P ^a | I | P | I | I | I | S | I |
| Toluene | I | I | P ^b | I | P | I | P | P ^b | S | I |
| Chloroform | I | 1-3,500 yrs | P ^a | I | I | P | I | P ^a | S | I |
| Methylene Chloride | I | 1-704 yrs | P | I | I | P | I | P | S | I |
| Ethylbenzene | I | I | P | I | P | I | P | P | S | I |
| Polychlorinated Biphenyls | I | I | days-mos ^{b,e} | S | I | I | P ^e | days-mos ^e | mos-yrs | S |
| Phenol | I | I | S | I | P | I | P | S | P | I |
| Phthalates | I | I | P | S ^f | I | P | I | P | I | S ^f |
| 1,2-Dichloroethane | I | I | I | I | I | I | I | I | S | I |
| 1,1-Dichloroethane | I | I | days | S | I | I | I | days | P | S |

Notes: S = Significant

I = Insignificant

M = Moderate

P = Possible

^aUnder anaerobic conditions.

^bUnder aerobic conditions.

^cClear, well aerated systems.

^dWaters high in iron and copper.

^eDepends on degree of chlorination.

^fDepends on the compound.

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Table 5-3 (Page 2 of 2)

| Compound | Aquatic Systems | | | | | |
|---------------------------|-----------------|-------------------|----------------|---------------------------|----------------|----------------|
| | Transformation | | | | Transfer | |
| | Oxidation | Hydrolysis | Photolysis | Biodegradation | Volatilization | Sorption |
| 1,1,1-Trichloroethane | I | I 6 mos - 1 yr | I | M P ^a | min - hrs | I |
| 1,1,2-Trichloroethane | I | I 6 mos - 1 yr | I | P ^a | min - hrs | I |
| Tetrachloroethene | 8.8 mos | I | I | P ^a | min - hrs | I |
| Trichloroethene | 10.7 mos | I | I | P ^a | min - days | I |
| Toluene | P | I | P | P ^b | hrs | I |
| Chloroform | I | 1-3,500 yrs | I | P | min - hrs | I |
| Methylene Chloride | I | 1-704 yrs | I | P | min - hrs | I |
| Ethylbenzene | P | I | P | P | 5 - 6 hrs | I |
| Polychlorinated Biphenyls | I | I | P ^a | days - mos ^{b,e} | mos - yrs | S |
| Phenol | S | I | P | S | P | I |
| Phthalates | I | P | I | P | I | S ^f |
| 1,1,1-Trichloroethane | I | I | I | I | min - hrs | I |
| 1,1,2-Trichloroethane | I | I | P | P | P | S |

Notes: S = Significant

I = Insignificant

M = Moderate

P = Possible

^a Under anaerobic conditions.^b Under aerobic conditions.^c Clear, well aerated systems.^d Waters high in iron and copper.^e Depends on degree of chlorination.^f Depends on the compound

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le D-3
SUMMARY OF ENVIRONMENTAL BEHAVIOR OF INDICATOR METALS IN
SUBSURFACE SOILS, GROUNDWATER, SURFACE SOILS, AND AQUATIC SYSTEMS

| Compound | Subsurface Soils and Groundwater | | | Surface Soils | | | | Aquatic Systems | | | |
|----------|----------------------------------|-------------------|----------|-------------------------|-------------------|---------------------|----------|-------------------------|-------------------|---------------------|----------|
| | Transformation | | Transfer | Transformation | | Transfer | | Transformation | | Transfer | |
| | Oxidation- Reduction | Biotransformation | Sorption | Oxidation- Reduction | Biotransformation | Volatil- ization | Sorption | Oxidation- Reduction | Biotransformation | Volatil- ization | Sorption |
| Arsenic | S | P | S | S | P | P | S | S | P | P | S |
| Cadmium | I | I | S | I | I | I | S | I | I | I | S |
| Chromium | S | I | S | S | I | I | S | S | I | I | S |
| Copper | S | I | S | I | I | I | S | I | I | I | S |
| Nickel | I | I | S | I | I | I | S | I | I | I | S |
| Lead | I | P | S | I | P | P | S | I | P | P | S |
| Zinc | I | I | S | I | I | I | S | I | I | I | S |

S = Significant
I = Insignificant
P = Possible

D-5

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sector is mainly controlled by sorption. Both tables list if the mechanism has a significant (S), insignificant (I), or moderate (M) impact on behavior. In cases where the significance is uncertain or dependent on environmental conditions, the mechanism is denoted as possible (P).

Environmental behavior profiles are provided in Appendix C for each indicator chemical. The following section summarizes site characteristics important to contaminant transport.

KEY SITE CHARACTERISTICS

Groundwater

The key site characteristics are rate of leachate flow to the ^{groundwater aquifer} shallow-saturated zone and travel time of groundwater from the site to both the unnamed ditch and Finley Creek. Using an estimated 7.8 inches of recharge water per year to the shallow saturated zone, the leachate rate was calculated as 568 gallons per year per square foot (200 liters/per year per square meter). Groundwater velocities for the shallow saturated zone were calculated assuming flow from the eastern portion of the site is directed to the unnamed ditch and that flow from the northern and western portions is directed to either the unnamed ditch or Finley Creek. The average horizontal gradient for the eastern portion was

estimated to be 0.05 feet per foot and for the northwestern portion to be 0.02 feet per foot. An effective porosity of 0.20 was used and the average hydraulic conductivity was estimated as 10^{-5} centimeters per second. The resulting groundwater velocities are 1.0 ft/yr for the northwestern portion and 2.6 ft/yr for the eastern portion. Contaminant velocities and travel times were then calculated using retardation factors.

In the shallow sand and gravel aquifer, the average hydraulic conductivity was estimated to range from 10^{-2} to 10^{-3} centimeters per second and the porosity was assumed to be 0.30. Using an average gradient of 0.03 feet per foot, the groundwater velocities were calculated to be around 100 to 1,000 feet per year.

Surface Water

Flow rate in the unnamed ditch was estimated to be 0.1 cfs and flow in Finley Creek reportedly ranges from 0.1 to 4 cfs. Assuming a 1 fps velocity in the ditch, the travel time for contaminants to reach Finley Creek would be from 5 to 20 minutes. Finley Creek discharges into Big Eagle Creek which has a flowrate ranging from 25 cfs to 150 cfs. Big Eagle Creek eventually discharges into the Eagle Creek Reservoir which contains between 4.7×10^9 and 8.1×10^9 gallons of water.

INDICATOR CHEMICAL TRANSPORT AND FATE

The site-specific behavior of the indicator chemicals can be discussed in terms of the profiles presented in Appendix C and some basic site characteristics. It is convenient to group the indicator chemicals as follows given similarities in their behavior: volatile organics, phenols, phthalates, and PCB's^{and metals}. Transport and fate of the indicator chemicals are based on a literature review and site characteristics. Due to the relatively limited literature available and the many estimates and assumptions necessary, the transport and fate calculated here are gross best estimates only. Actual transport and fate may vary by orders-of-magnitude.

Methodology

In order to estimate degradation (whether biotic or abiotic) it was assumed that degradation occurred according to the formula:

$$C = C_0 - \frac{c \cdot t}{T_m + t}$$

where: t = time
 c = concentration at time t
 c_0 = initial concentration
 T_m = half-life; time when $c = \frac{1}{2}c_0$

Assuming the curve remains linear until $t=T_m$, half-life values were calculated from first order rates found in the literature (Half-lives were also obtained from the literature). Each indicator compound was researched individually and wherever possible degradation rates were obtained for each compound under the various site conditions (i.e., soil, groundwater, surface water, and air). When values could not be found in the literature, rates for those compounds were assumed to be the same as structurally similar compounds. Using average and maximum concentrations for c_0 and the derived concentration for c , the above equation was solved for t . An example calculation is shown in Appendix C.

The methodology assumes that as a compound degrades and becomes limiting, the degradation rate approaches zero. The ~~equation is an adaptation of the Michaelis-Menten~~ relationship and results in a more conservative estimate of degradation than a simple first order rate equation. Each compound was considered the sole source in the degradation process and no effects from temperature changes or chemical interactions were considered.

Volatile Organics

Although volatile organics were detected in ponding surface water, they should readily volatilize and should not persist in surface soils or ponding water at the ECC site.

Volatiles are present in elevated concentrations in the subsurface soil. Overall volatile organics exhibit high mobility and are therefore most likely to be leached out of the contaminated soil. If leaching is prevented, it is estimated that all the indicator volatiles except 1,1,1-TCA, TCE, and PCE will degrade (by either biodegradation or abiotic degradation) to acceptable levels within 10 years. (Acceptable levels are assumed to be concentrations in the soil which will not result in excess lifetime cancer risk greater than 10^{-6} or daily chemical intakes greater than the acceptable daily intakes based on the assumptions outlined in the Endangerment Assessment in the next chapter.) Degradation of PCE to acceptable levels is estimated to take less than 10 years based on site average concentrations but from 100 to 500 years based on maximum concentrations. TCE and 1,1,1-TCA are estimated to degrade to acceptable levels in less than 100 years and 20 years, respectively, at site average concentrations and from 500 to 1,000 years at maximum concentration.

Under existing site conditions, the volatile organics will leach from the unsaturated soil into the groundwater and slowly migrate towards the unnamed ditch or Finley Creek. Estimated concentrations in the groundwater are shown in Table 5-4. The travel times to reach the surface waters will vary greatly depending upon the compound, soil properties, the hydraulic conductivity, and the travel distance.

Estimates for travel time from the eastern portion of the site to the ditch are as follows:

| | |
|----------------------|-----------------------------|
| methylene chloride | 20 to 70 years |
| chloroform | 30 to 120 years |
| 1,1,1-TCA | 40 to 150 years |
| 1,1,2-TCA | 40 to 150 years |
| TCE | 50 to 200 years |
| toluene | 100 to 400 years |
| PCE | 150 to 600 years |
| ethylbenzene | 300 to 1,000 years |

These estimates were based on a hydraulic conductivity of 10^{-5} cm/sec and would be an order-of-magnitude less using 10^{-4} cm/sec (i.e., 2 to 7 years for methylene chloride).

Estimates for travel time from the northwestern portion of the site to the ditch and Finley creek are as follows:

o Unnamed Ditch:

| | |
|----------------------|------------------------|
| methylene chloride | 250 years |
| chloroform | 400 years |
| 1,1,1-TCA | 500 years |
| 1,1,2-TCA | 500 years |
| TCE | 650 years |
| toluene | 1,300 years |
| PCE | 2,000 years |
| ethylbenzene | 3,400 years |

o Finley Creek:

| | |
|----------------------|------------------------|
| methylene chloride | 600 years |
| chloroform | 1,000 years |
| 1,1,1-TCA | 1,300 years |
| 1,1,2-TCA | 1,300 years |
| TCE | 1,600 years |
| toluene | 3,200 years |
| PCE | 5,000 years |
| ethylbenzene | 8,400 years |

Again these estimates were calculated using a hydraulic conductivity of 10^{-5} cm/sec.

Considering the significant travel times, 1,1,1-TCA and 1,1,2-TCA will likely experience degradation given the magnitude of ^{its} their hydrolysis rates. Because the groundwater is relatively shallow, it is likely that aerobic conditions exist. If this is the case, trichloroethene and ^{should} tetrachloroethene will also experience some degradation. Degradation of the remaining volatiles does not appear likely, but will depend on the actual conditions. Some species of bacteria, for instance, have been shown to be able to degrade ethylbenzene.

Assuming no degradation of the compounds, concentrations in the surface waters following complete mixing with the groundwater are listed in Table 5-5.

Concentrations in the surface waters due to discharge of contaminated water from the shallow sand and gravel aquifer are estimated to be the following:

| | | | |
|--------------------|-----------------|---------------|---------------------|
| 1,1-Dichloroethene | 0.024 | to | 0.24 ug/L |
| TCE | 0.064 | to | 0.64 ug/L |
| Methylene chloride | 0.19 | to | 1.9 ug/L |
| PCE | 0.03 | to | 0.3 ug/L |

(assuming $K = 10^{-3}$ cm/s)

The volatiles that reach the surface waters should readily volatilize if environmental conditions (e.g., temperature) are favorable. Any contaminants remaining in the surface water would experience a 1:8 to a 1:40 dilution upon entering Big Eagle Creek and then a further dilution within the Eagle Creek reservoir.

Once in the atmosphere, the volatiles should degrade via photooxidation. The volatiles should not be found in high concentrations in the surface water sediments. Figure 5-2 summarizes the transport and fate of the volatile organics at ECC.

Phenols

Phenol in the subsurface soil is already below acceptable levels and is estimated to degrade at a rate which would result in only trace levels remaining after 5 to 10 years.

Phenol is easily desorbed from soil, however, and would readily leach into the groundwater. Phenol concentrations in groundwater are estimated to be about 80 mg/L based on average soil concentrations and about 4,000 mg/L based on maximum soil concentrations. Estimates of travel times from the eastern portion of the site to the unnamed ditch range from 20 to 80 years using a hydraulic conductivity of 10^{-5} cm/sec. Travel time from the northwestern portion of the

site to the ditch and Finley Creek using 10^{-5} cm/sec are estimated to be 300 years and at least 650 years, respectively.

Degradation will most likely occur considering the long travel time and the biodegradability of phenol. Assuming no degradation, phenol concentrations are estimated to be on the order of 50 to 150 ug/L in the ditch. Phenol concentrations in Finley Creek following mixing are estimated to be about 5 to 50 ug/L. If degradation is considered, the concentrations are estimated to be in the range of 0.2 to 10 ug/L in the ditch, and 0.9 to 30 ug/L in Finley Creek depending on travel time ($k = 10^{-5}$ cm/sec). Once in the surface waters phenol should degrade more rapidly since aeration enhances the reduction of phenol by microorganisms.

Volatilization of phenol will not be significant, nor will sorption in surface water sediments. Figure 5-3 summarizes the transport and fate of phenols at ECC.

Phthalates

Phthalate esters in the subsurface soil are already below acceptable levels and are estimated to biodegrade to trace levels within 100 to 200 years.

The phthalates found at ECC exhibit a range of physical-chemical properties. Bis(2-ethylhexyl) phthalate and di-n-butyl phthalate both have low solubilities and high soil-water partition coefficients. Diethyl and dimethyl phthalate have much higher solubilities and much lower partition coefficients. Consequently, the latter two exhibit some mobility within the environment and will leach from the contaminated soil into the groundwater. Only trace concentrations of bis(2-ethylhexyl)phthalate and di-n-butyl phthalate will appear in the groundwater:

| | <u>Concentration (ug/L)</u> | |
|----------------------------|-----------------------------|----------------|
| | <u>Average</u> | <u>Maximum</u> |
| Diethyl phthalate | 50 | 1,100 |
| Dimethyl phthalate | 125 | 2,000 |
| Di-n-butyl phthalate | 0.50 | 10 |
| Bis(2-ethylhexyl)phthalate | 0.005 | 0.15 |

Estimated travel times from the eastern portion of the site to the unnamed ditch range from 40 to 150 years for dimethyl and 300 to 1,100 years for diethyl phthalate using 10^{-5} cm/sec. Travel times for the northwestern portion of the site are orders of magnitude higher.

Degradation will most likely occur since biodegradation is a significant mechanism in the ultimate fate of the phthalate

esters. However, concentrations in the unnamed ditch are estimated to be less than 4 ug/L assuming no degradation. Estimated concentrations in Finley Creek are even lower and will be reduced considerably if degradation is considered.

Volatilization of phthalates will not be a significant pathway since they have very low vapor pressures. Phthalates should not be able to migrate to surface water sediments except in trace quantities unless there is direct runoff or discharge to the creek. Once in the surface water the phthalates will adsorb readily and tend to persist in the sediments. Figure 5-4 summarizes the transport and fate of phthalates at ^{EC}ECC.

PCB's

PCB's will tend to persist in surface and subsurface soils. Some degradation may occur in onsite surface soils through volatilization, photolysis, and biodegradation. Subsurface degradation will be limited and (as with surface soils) will vary with the type of PCB mixture. Degradation to acceptable levels is estimated to take 50 years at site average concentrations and approximately 100 to 2,000 years at maximum concentrations.

PCB's readily adsorb to soil and have low solubilities. Of the two detected at ECC, only 1232 will leach into the groundwater and only in trace concentrations (25 ug/L based on average soil concentrations). PCB's are, however, not likely to migrate within the aquifer. If PCB's enter the ditch or creek by surface runoff or direct discharge, they would absorb readily to the sediments. Figure 5-5 summarizes the transport and fate of PCB's at ^{W.}ECC.

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METHYLENE CHLORIDE

The behavior of methylene chloride will be controlled by its vapor pressure. Methylene chlorine will not persist in surface soils or aquatic systems because of its tendency to volatilize. Callahan et al. (1979) give a volatilization half-life in water on the order of several minutes to a few hours depending upon the degree of agitation. In the atmosphere, methylene chloride degrades rapidly as a result of photo-oxidation by hydroxyl radical attack producing phosgene and chlorine oxide. Callahan et al. (1979) give a photo-oxidation half-life on the order of several months.

While hydrolysis of methylene chloride in water is possible, the rate of degradation is slow relative to volatilization. Callahan et al. (1979) present a minimum half-life of 18 months based on experimental work by Dilling et al. (1979). A maximum half-life of 704 years is also given based on an extrapolation made by Radding et al. (1977). Oxidation and photodecomposition are not significant, if they occur at all.

Sorption of methylene chloride will be limited given its octanol-water partition coefficient. The extent of sorption is controlled by the organic matter content and surface area of clays (Dawson et al., 1980). Methylene chloride mobility in aquatic systems will be controlled by water (rather than sediment) movement.

There is some uncertainty as to how persistent methylene chloride is in subsurface soils and groundwater. While hydrolysis can occur, it is difficult to estimate a rate of degradation. Given appropriate acclimation, biodegradation of methylene chloride is possible but at a very slow rate.

The mobility of methylene chloride in subsurface soils and groundwater will be high.

PHENOL

Photo-oxidation, metal-catalyzed oxidation, and biodegradation probably all contribute to the fate of phenol in the aquatic environment. Photo-oxidation will gradually occur, but only in aerated and clear surface waters. Callahan et al. (1979) suggests, however, that phenol may be nonphotolytically oxidized in highly aerated waters that also contain iron and copper.

Hydrolysis and volatilization of phenol are probably not environmentally significant processes. There is a possibility that some volatilization can occur, but, once in the atmosphere, phenol would be rapidly destroyed by oxidation in the troposphere. Since sorption of phenol is limited, it appears to be highly mobile in soils and groundwater.

Biodegradation is probably the most significant process in the environmental fate of phenol. Its microbial degradation has been observed in many laboratory and in situ studies.

Visser et al. (1977) estimated a removal rate of 30 ug/L per hour by bacteria in river water. Alexander and Lustingman (1966) reported that phenol was rapidly degraded by a mixed population of soil microbes.

PHTHALATE ESTERS

Phthalate's are a family of compounds whose environmental behavior may vary somewhat from compound to compound. In general, the mobility of the phthalates is controlled by their high affinity for sorption and, to some extent, by their limited solubilities. Although dimethyl and diethyl phthalate have moderate solubilities, most phthalates have very low solubilities. Their mobility in aquatic systems is mainly controlled by sediment transport processes. Ogner and Schnitzer (1970) suggest an interaction between phthalates and fulvic acid in humic substances in water and soil. The result is a very soluble complex, thus mobilizing and transporting otherwise insoluble phthalate esters.

Photolysis and oxidation are not expected to be significant processes. Hydrolysis is expected to occur in surface waters, but at very slow rates. The half-lives for the hydrolysis

of phthalate esters are expected to be on the order of years (Callahan et al., 1979).

Vapor pressures for phthalate esters are extremely low and the evaporative half-life for bis(2-ethylhexyl)phthalate is estimated to be 15 years (Branson, 1978).

Phthalate esters are thought to undergo microbial degradation much more easily than other persistent compounds, such as PCB's (Engelhardt et al.). Half-lives have been reported on the range of 2 days for butyl benzyl phthalate to 4 weeks for bis(2-ethyl hexyl)phthalate (Callahan et al., 1979). Mathur (1974a) reported biodegradation in soils under aerobic conditions. Johnson and Lulves (1975) reported that degradation occurred much slower or not at all under anaerobic conditions.

Mobility of phthalate in subsurface soil and groundwater will be low to moderate depending upon the compound.

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The ultimate fate of naphthalene appears to be biodegradation (by conjugation and metabolism & biotransformation) by multicellular organisms. Lee and Day (1972) measured microbial degradation rates as high as 4 ug/g per day for naphthalene in soil. Lee and Day (1972) also found that naphthalene decay rate in soil was 0.4 ug/g per day. The biotransformation of naphthalene in soil is a complex process involving a number of steps including conjugation, oxidation, and reduction. The biotransformation of naphthalene in soil is a complex process involving a number of steps including conjugation, oxidation, and reduction.

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made by Radding et al. (1977). Dawson et al. (1980) give a hydrolysis half-life of 18 months. Oxidation and photodecomposition are not significant, if they occur at all.

Sorption of chloroform will be limited given its octanol-water partition coefficient. The extent of sorption is controlled by the organic matter content and surface area of clays (Dawson et al., 1980). Chloroform mobility in aquatic systems will be controlled by water (rather than sediment) movement.

There is some uncertainty as to how persistent chloroform is in subsurface soils and groundwater. While hydrolysis can occur, it is difficult to estimate a rate of degradation. Given appropriate acclimation, biodegradation of chloroform is possible under anaerobic conditions (Bouwer and McCarty, 1983).

The mobility of chloroform in subsurface soils and groundwater will be high.

POLYCHLORINATED BIPHENYLS

Polychlorinated biphenyls (PCB's) are a family of compounds whose environmental behavior can vary widely depending upon the degree of chlorination. In general, as the degree of chlorination increases so does the persistence and affinity

for sorption; volatility and solubility decrease with degree of chlorination.

The mobility of PCB's is largely controlled by their high affinity for sorption and, to some extent, by their limited solubility in water. PCB sorption is a function of organic matter content and clay content, the former being the more important (Griffin and Chian, 1980). The mobility of PCB's in aquatic systems is controlled by sediment transport processes. Areas of high sediment deposition can become sinks of PCB and later sources as the PCB redissolves into the water column. PCB mobility in subsurface soils and groundwater is limited by sorption. However, under conditions where PCB is present in excess of its solubility, there is the potential for migration as a separate phase. Roberts et al. (1982) found that the migration of PCB as a separate phase in soil and groundwater explained why contamination at a spill site was more widespread than would be expected given its affinity for sorption.

Despite their relatively low vapor pressure and molecular weight, PCB volatilization from water and soil can occur. Adsorption dramatically reduces the rate of volatilization, however. Pal et al. (1980) has summarized volatilization half-lives for PCB's in water and soils. They range from tens to hundreds of days depending upon the type of PCB mixture and environmental conditions. Volatilization is an

important mechanism because of the lack of other mechanisms that act to degrade PCB's.

The only important degradation process is biodegradation. However, it is only significant for the mono-, di-, and tri-chlorinated biphenyls. Biphenyls with five or more chlorines are essentially unaffected, while tetrachlorobiphenyls are moderately susceptible (Callahan et al., 1979). Leifer et al. (1983) state that there is no evidence for PCB biodegradation under anaerobic conditions, but that numerous aerobic microorganisms are capable of degrading PCB's. Table 1 gives estimates for biodegradation half-lives in different media.

Table 1
HALF-LIVES OF PCB'S RESULTING FROM BIODEGRADATION
(Source: Leifer et al., 1984)

| | <u>Mono- & Dichloro</u> | <u>Trichloro</u> | <u>Tetrachloro</u> | <u>Pentachloro and Higher</u> |
|------------------|-----------------------------|----------------------|--------------------|-------------------------------|
| Aerobic | | | | |
| Surface Waters | | | | |
| Fresh | 2-4 days | 5-40 days | 1 wk-2+ mos. | >1 year |
| Oceanic | -----several months----- | ----- | ----->1 year----- | ----- |
| Activated Sludge | 1-2 days | 2-3 days | 3-5 days | * |
| Soil | 6-10 days | -----12-30 days----- | | >1 year |
| Anaerobic | ----- | ∞ | ----- | ----- |

*It is not clear how long the highly chlorinated PCB's would last under activated sludge treatment but there appears to be no significant biodegradation during typical residence times.

More highly chlorinated PCB's in solution have been observed to break down through photolysis. Sufficient data are not available to estimate photolysis half-lives for environmental conditions (Leifer et al., 1983). PCB's are resistant to both oxidation and hydrolysis (Callahan et al., (1979; Leifer et al., 1983).

1,1,2-TRICHLOROETHANE

The behavior of 1,1,2-trichloroethane is largely controlled by its high vapor pressure. 1,1,2-trichloroethane will not persist in surface soils and aquatic systems because of its tendency to volatilize. Callahan et al. (1979) give an aquatic volatilization half-life on the order of several minutes to a few hours, depending upon the degree of agitation. Once in the atmosphere, 1,1,2-trichloroethane will tend to slowly degrade via photo-oxidation, with a reported half-life ranging from 0.5 to 3 years (Callahan et al., 1979).

Oxidation and hydrolysis of 1,1,2-trichloroethane in soils and aquatic systems proceed at rates that are slow relative to volatilization. The half-life for hydrolysis is estimated to be about 6 months; the half-life for oxidation is unknown, but is reported to be very slow (Callahan et al., 1979). Thus, these fate mechanisms are insignificant in aquatic systems. Photodissociation in water or air is not expected to occur (Jaffe and Orchin, 1962).



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CHLORDANE

The mobility and persistence of chlordane in the environment appear to be determined by volatilization, sorption and biodegradation. Despite a relatively low K_{ow} of 10,000, volatilization of chlordane has been shown to be a significant transport process (Herman et al., 1964) and is related to water sorption ~~coefficient~~. As a result, mobility is related to water sorption surface area, volatility by mass, and sediment partition coefficient; whereas, mobility in subsurface water is controlled by sorption and is controlled by soil sorption coefficient and a limited solubility.

Although chlordane is known to undergo photodegraded reactions, no data are available to assess the significance of photolysis in a field environment. However, the degradation of chlordane in the environment is a function of the rate of degradation.

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the value of the concentration of the
at the 1977 present a hydrologic half life
of at least four years.

Concentration of the substance in the
the concentration of the substance in the
concentration of the substance in the
the concentration of the substance in the
the concentration of the substance in the
the concentration of the substance in the
the concentration of the substance in the
the concentration of the substance in the

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show evidence of sexual abuse. Smith et al. (1977) present a syndrome of 14 of at least four years.

Discontinuation of the *Journal* has
 been suggested, but it is not
 so important. Circulation figures
 for *lectures*, *disputes*, etc. are
 all a lot of nothing. It is a
 very slow process, but it is
 the only way to get the

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microorganisms are capable of degrading gives estimates for biodegradation half-media.

Table D-4
HALF-LIVES OF PCB'S RESULTING FRO
(Source: Leifer et al.,

| | <u>Mono- & Dichloro</u> | <u>Trichloro</u> | <u>Tetrachloro</u> | <u>Pentachloro and Higher</u> |
|------------------|-----------------------------|----------------------|--------------------|-------------------------------|
| Aerobic | | | | |
| Surface Waters | | | | |
| Fresh | 2-4 days | 5-40 days | 1 wk-2+ mos. | >1 year |
| Oceanic | -----several months----- | ----- | ----- | ----->1 year----- |
| Activated Sludge | 1-2 days | 2-3 days | 3-5 days | * |
| Soil | 6-10 days | -----12-30 days----- | | >1 year |
| Anaerobic | ----- | ----- | ----- | ----- |

*It is not clear how long the highly chlorinated PCB's would last under activated sludge treatment but there appears to be no significant biodegradation during typical residence times.

More highly chlorinated PCB's in solution have been observed to break down through photolysis. Sufficient data are not available to estimate photolysis half-lives for environmental conditions (Leifer et al., 1983). PCB's are resistant to both oxidation and hydrolysis (Callahan et al., (1979; Leifer et al., 1983).

OXAZOLIDONE

Few data are available for use in constructing an environmental fate profile for 3-(2-hydroxypropyl)-5-methyl-2-oxazolidionone (oxazolidone). Literature on the persistence of this compound do not exist. The compound may biodegrade in the soil environment. The rate at which this process would occur is unknown.

ARSENIC

In the natural environment, four oxidation states are possible for arsenic: -3, 0, +3, and +5. The +3 and +5 states are most commonly found in aqueous solutions, with the +5 state being the most stable and dominant. The -3 state is present in arsine (AsH_3) and is stable only under highly reduced conditions.

The environmental behavior of arsenic is largely determined by pH and the oxidation-reduction (i.e., redox) potential of the system. Rai et al. (1984) state that under oxidizing conditions, H_2AsO_4^- and HAsO_4^{2-} are the most common species, while H_3AsO_3 , H_2AsO_3^- and H_2AsO_4^- are most common under reduced conditions. Biologically mediated reactions and dissolved organic matter also have a significant impact on arsenic speciation.

Dissolved arsenic concentrations can be reduced by precipitation/dissolution reactions. These reactions have not been well characterized. Rai et al. (1984) state that FeAsO_4 is a possible solubility-controlling solid.

Dissolved arsenic concentrations can be further reduced by sorption reactions. Rai et al. (1984) note that the iron and aluminum hydrous oxide content of a soil or sediment will control the extent of sorption. Organic matter content and pH do not seem to have a significant impact. In general, arsenic is strongly adsorbed with the As(V) species showing a much greater affinity than As(III) species. Callahan et al. (1979) conclude that arsenic adsorption will be most significant in aerobic, acidic, fresh waters.

Arsenic mobility in aquatic systems will be controlled by sediment movement. In subsurface soils and groundwater, arsenic will be relatively immobile with the As(V) species being less mobile than the As(III) species.

In areas of high biological activity, arsenic can be mobilized through methylation reactions. Methylarsines can be produced by a number of yeasts, bacteria, and fungi (Callahan et al., 1979). These compounds can readily volatilize from water. Arsenic can also volatilize under highly reducing conditions as arsine (AsH_3). Arsine is rapidly oxidized, however, upon introduction to aerobic waters or the atmosphere (Callahan et al., 1979).

CADMIUM

In aqueous solutions, cadmium exists only in the +2 state. Dissolved cadmium can be in a free ionic form or an inorganic or organic complex. Generally, the most dominant species is Cd^{2+} . As conditions become more alkaline (i.e., pH > 8-9), hydroxide and carbonate complexes become dominant. In organically polluted waters, cadmium can be readily complexed.

Most natural waters are undersaturated with respect to known solubility controlling phases for cadmium (Callahan et al., 1979). For alkaline soils, CdCO_3 and, in some cases, $\text{Cd}_3(\text{PO}_4)_2$ can be solubility-controlling solids (Rai et al., 1984).

Cadmium is adsorbed by soils and sediments containing aluminum, iron, and manganese oxides. In highly polluted aquatic systems, sorption onto organic materials can be significant (Callahan et al., 1979). Rai et al. (1979) note that competition with other cations (e.g., copper, lead, and zinc) and calcium and magnesium can reduce cadmium adsorption. They further note that there is a close relationship between cadmium adsorption and the cation exchange capacity of a soil. Cadmium adsorption shows a strong pH dependency with the extent of adsorption decreasing with pH.

Cadmium mobility in aquatic systems will be controlled by sediment movement. In subsurface soils and groundwater, cadmium will be relatively immobile.

Cadmium is not transformed or attenuated via biological activity. Thus, its persistence in soils, groundwater, and aquatic systems will be high.

CHROMIUM

In aqueous systems, chromium exists in two oxidation states: +3 and +6. Redox potential and pH both play an important role in determining their relative presence and mobility. Trivalent species can exist over a relatively wide range of redox and pH conditions; hexavalent species occur only under strongly oxidizing conditions.

Above a pH of 5, trivalent species rapidly precipitate as an oxide or hydroxide solid. Cr_2O_3 is probably the solubility-controlling solid under moderately oxidizing conditions, while FeCr_2O_4 may control under slightly reduced conditions (Rai et al., 1984).

Under oxidizing conditions hexavalent chromium exists as hydrochromate, chromate, and dichromate species. Their relative distribution varies with pH. In the pH range of natural waters, hydrochromate predominates, while chromate predominates in the alkaline range. Hexavalent chromium is a moderately strong oxidizing agent that can react with reducing materials to form trivalent chromium.

Both trivalent and hexavalent chromium are adsorbed onto inorganic solids, with trivalent chromium showing a stronger affinity than hexavalent chromium. Trivalent chromium may be strongly adsorbed by iron and manganese oxides (Rai et al., 1984). The affinity for trivalent chromium adsorption increases with pH. The presence of organic ligands can result in the formation of complexes that will limit adsorption. Hexavalent chromium is specifically adsorbed by iron oxides under acidic conditions; it is relatively mobile under neutral and basic conditions (Rai et al., 1984). Hexavalent

chromium adsorption may decrease in the presence of competing ions like SO_4^{2-} .

Chromium mobility in aquatic systems will be controlled by sediment movement. In subsurface soils and groundwater, chromium will be relatively immobile.

Biotransformation is not an important mechanism for chromium. Thus, its persistence in soil, groundwater, and aquatic systems will be high.

COPPER

Copper in aqueous solutions can exist in a +1 or +2 state. It has a pronounced tendency to form a number of inorganic and organic complexes. Under oxidizing conditions, Cu^{2+} or a Cu(II) complex with OH^- , CO_3^{2-} or SO_4^{2-} will dominate depending upon the pH and ligand concentrations; under reducing conditions, Cu^+ or a Cl^- complex will dominate.

Dissolved copper concentrations are typically controlled by the formation of $\text{Cu}(\text{OH})_2$. In waters containing organic ligands, copper can form complexes that alter its solubility and precipitation behavior.

According to Rai et al. (1979), copper can adsorb to organic matter and iron and manganese oxides. Its affinity for adsorption is strongly dependent upon speciation since CuOH^+ is preferred over Cu^{2+} . Callahan et al. (1979) further note that in organically rich waters the ultimate dissolved copper concentration will be determined by competition between organic ligands and organic sorbants and clay particles. Thus, it is difficult to predict with certainty how copper will behave in polluted waters. In general, its mobility in aquatic systems will be controlled by sediment movement. In subsurface soils and groundwater, copper will be relatively immobile.

Biotransformation is not an important mechanism for copper. Thus, its persistence in soil, groundwater, and aquatic systems will be high.

NICKEL

Nickel exists in aqueous solutions in the +2 valence state. Under reduced conditions and in the presence of sulfide, nickel forms an insoluble complex. Under oxidizing conditions below a pH of 9, nickel will complex with hydroxide, carbonate, and sulfate ligands. Nickel will also readily complex with organic ligands. The resulting complexes are highly soluble.

Rai et al. (1984) found NiFeO_2 to be the most probable solubility-controlling solid under oxidizing conditions; NiS controls under reduced conditions.

Nickel can sorb on solids containing iron and manganese oxides and organic material. Callahan et al. (1979) note, however, that nickel is not extensively sorbed. Competition with Ca^{2+} and Mg^{2+} and inorganic and organic complexation can reduce nickel adsorption. Despite its relative mobility compared to other metals, nickel mobility in aquatic systems will be controlled by sediment transport. Nickel will be relatively immobile in subsurface soils and groundwater. 14

Biotransformation is not an important mechanism for nickel. Thus, nickel will be persistent in soil, groundwater, and aquatic systems.

LEAD

Lead is largely present in a +2 valence state in most aqueous solutions. The +4 state is stable only under highly oxidizing conditions that are not environmentally significant. Lead has a strong tendency to form hydroxide, carbonate, sulfide, and sulfate complexes. It also has a strong tendency to form organic complexes that can have a major effect on solubility controls and sorption.

Rai et al. (1984) state that lead-phosphates are probable solubility-controlling solids in noncalcareous soils, while PbCO_3 appears to control in calcareous and alkaline soils.

Lead is strongly adsorbed to solids containing iron and manganese oxides. According to Rai et al. (1984), it is also retained by ion exchange; competing ions have little effect on lead sorption at low concentrations. The affinity of lead for adsorption increases with the degree of organic complexation and with increasing pH. The mobility of lead in aquatic systems will be determined by sediment movement. Lead will be immobile in subsurface soils and groundwater.

Lead concentrations in surface soils and bed sediments can be reduced as a result of biologically mediated reactions. Lead methylation can produce a volatile compound (i.e., trimethyl lead) that either enters the atmosphere or is oxidized in the water column. Sufficient data are not available to determine under what exact conditions methylation will occur or at what rate.

ZINC

Zinc has an oxidation state of +2 in aqueous systems. Zinc can exist in its free ionic form or as an inorganic or organic complex. Under oxidizing conditions, hydroxide,

Yes I
want
this
section!

Table 5-5
ESTIMATED CONCENTRATIONS OF VOLATILE ORGANICS IN SURFACE
WATER DUE TO GROUNDWATER DISCHARGE

| Compound | Unnamed Ditch ^a | Unnamed Ditch ^b | Finley Creek ^c |
|-----------------------|-------------------------------|-------------------------------|---------------------------|
| Chloroform | 0.31 | 0.1 | 0.01 to 0.1 |
| Methylene Chloride | 170 | 60 | 6 to 60 |
| 1,1,1-TCA | 70 | 25 | 2.5 to 25 |
| 1,1,2-TCA | 0.04 | 0.014 | 0.001 to 0.014 |
| TCE | 170 | 60 | 6 to 60 |
| PCE | 7 | 3 | 0.3 to 3 |
| Toluene | 50 | 16 | 1.6 to 16 |
| Ethylbenzene | 10 | 3 | 0.3 to 3 |

^a Concentrations in the unnamed ditch due to groundwater discharge from the eastern portion of the site.

^b Concentrations in the unnamed ditch due to groundwater discharge from the northwestern portion of the site.

^c Concentrations in Finley Creek due to groundwater discharge from the northwestern portion of the site. Concentrations vary depending on the flow rate.

NOTE: Concentrations were estimated assuming a hydraulic conductivity of 10^{-5} cm/s.
Values would be 10 times higher using 10^{-4} cm/s.

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Table 5-4
ESTIMATED CONCENTRATIONS OF VOLATILE ORGANICS
IN GROUNDWATER DUE TO LEACHING

| <u>Compound</u> | <u>Concentration (ug/L)</u> | |
|--------------------|-----------------------------|----------------|
| | <u>Average</u> | <u>Maximum</u> |
| Chloroform | 188 | 6,000 |
| Methylene Chloride | 101,250 | 3,500,000 |
| 1,1,1-TCA | 40,250 | 1,100,000 |
| 1,1,2-TCA | 25 | 825 |
| TCE | 100,000 | 275,000 |
| PCE | 4,000 | 50,000 |
| Toluene | 28,250 | 133,750 |
| Ethylbenzene | 5,500 | 38,000 |

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J. Hill, et al., Dynamic response of single
CHLORIDE in Hydrogen Chloride, U.S. EPA
Office of Research and Development,
EPA 600/3-76-001 (1976).

M.C. Evans, et al., Hydrogen Chloride
Toxicity in Mice, containing
hydrogen chloride, EPA 600/3-76-001.

D. Rat and other, EPA 600/3-76-001.

Hydrogen Chloride, EPA 600/3-76-001.

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ENVIRONMENTAL PROFILES OF CONTAMINANTS

1,1,1-TRICHLOROETHANE

The behavior of 1,1,1-trichloroethane is largely controlled by its high vapor pressure. 1,1,1-trichloroethane will not persist in surface soils and aquatic systems because of its tendency to volatilize. Callahan et al. (1979) give an aquatic volatilization half-life on the order of several minutes to a few hours, depending upon the degree of agitation. Once in the atmosphere, 1,1,1-trichloroethane will tend to slowly degrade via photo-oxidation, with a reported half-life ranging from 1.1 to 8 years (Callahan et al., 1979).

Oxidation and hydrolysis of 1,1,1-trichloroethane in soils and aquatic systems proceed at rates that are slow relative to volatilization. The maximum reported half-life for hydrolysis is 6 months; the half-life for oxidation is unknown, but is reported to be very slow (Callahan et al., 1979). Thus, these fate mechanisms are insignificant in aquatic systems. Photodissociation in water or air is not expected to occur (Jaffe and Orchin, 1962).

Based on its octanol-water partition coefficient, sorption of 1,1,1-trichloroethane is expected to be limited. Dawson

et al. (1980) state that sorption of 1,1,1-trichloroethane will be proportional to the organic content of soils and surface area of clays. Thus, its mobility in aquatic systems will be controlled mainly by the rate of water movement rather than sediment movement.

The persistence of 1,1,1-trichloroethane in subsurface soils and groundwater will be controlled by hydrolysis. Biodegradation has been found to occur, but usually under anaerobic conditions as a result of reductive dehalogenation (Bouwer and McCarty, 1983). Thus, biodegradation will not be important in aerated subsurface soils and groundwater. The rate of biodegradation is difficult to estimate on a site-specific basis.

The mobility of 1,1,1,-trichloroethane in subsurface soils and groundwater will be high because it has little tendency for sorption.

TETRACHLOROETHENE

The behavior of tetrachloroethene is largely controlled by its vapor pressure. Tetrachloroethene will not persist in surface soils and aquatic systems because of its tendency to volatilize. The volatilization half-life for tetrachloroethene in water is on the order of several minutes to a few hours, depending upon the degree of agitation (Callahan et

Rates of biodegradation are difficult to estimate on a site-specific basis. Under aerobic conditions, tetrachloroethene may degrade as a result of oxidation.

The mobility of tetrachloroethene in subsurface soils and groundwater will be high because of its limited tendency for sorption.

TRICHLOROETHENE

The behavior of trichloroethene is largely controlled by its vapor pressure. Trichloroethene will not persist in surface soils and aquatic systems because of its tendency to volatilize. Its reported volatilization half-life from water is on the order of several minutes to a few days, depending upon the degree of agitation (Callahan et al., 1979). Once in the atmosphere, trichloroethene rapidly degrades via a photo-oxidation reaction that produces dichloroacetyl-chloride and phosgene. Callahan et al. (1979) give a 4-day half-life for this reaction.

While trichloroethene will degrade via photo-oxidation in surface soils and aquatic systems, the rate of degradation is slow relative to volatilization. Callahan et al. (1979) give a maximum oxidation half-life of 10.7 months. The relative contribution of hydrolysis is unclear given the

available data. It is expected to be insignificant in surface soils and aquatic systems, as is photodecomposition.

Sorption of trichloroethene will be limited due to its low octanol-water partition coefficient. Organic content will tend to control the extent of sorption. When the organic content is small compared to the clay content (less than 1 to 5), the inorganic fraction will control trichloroethene sorption (Richter, 1981). Its mobility in aquatic systems will be controlled by water (rather than sediment) movement.

The persistence of trichloroethene in subsurface soils and groundwater will be controlled by the degree of aeration. Biodegradation can occur under anaerobic conditions as a result of reductive dehalogenation (Bouwer and McCarty, 1983). Rates of biodegradation are difficult to estimate on a site-specific basis. Under aerobic conditions, trichloroethene may degrade as a result of oxidation.

The mobility of trichloroethene in subsurface soils and groundwater will be high because of its limited tendency for sorption.

TOLUENE

The behavior of toluene is controlled by its vapor pressure. Toluene will not persist in surface soils or aquatic systems because of its tendency to volatilize. Its estimated half-

life in water is on the order of a few hours (Callahan et al., 1979). Photo-oxidation of toluene in the atmosphere is rapid, with a half-life of about 15 hours (Callahan et al., 1979); this value is inferred based on the relative reactivity of toluene and reported conversion rates for m-xylene and 1,3,5-trimethylbenzene. Benzaldehyde is the major photo-oxidation byproduct for toluene (Laity et al., 1973).

While oxidation and photodecomposition are possible in water, the rates of degradation are probably slow relative to volatilization (Callahan et al., 1979). No rate data are available for either process. Hydrolysis is not expected to occur, according to Callahan et al. (1979). Thus, the persistence of toluene in surface soils and aquatic systems is largely controlled by volatilization.

Sorption of toluene will tend to be limited given its low octanol-water partition coefficient. Its mobility in aquatic systems will be controlled by water (rather than sediment) movement.

Toluene persistence in subsurface soils and groundwater will be high due to the insignificance of hydrolysis as a degradation mechanism. In addition, oxidation appears to occur only in the presence of sunlight. Biodegradation is possible given appropriate acclimation of soil bacteria and aerobic conditions (Callahan et al., 1979; Dawson et al., 1980).

Rates of biodegradation are difficult to estimate on a site-specific basis.

The mobility of toluene in subsurface soils and groundwater will be high. Sorption is directly related to organic matter content (Callahan et al., 1979). Given its density (0.866 g/cm^3), toluene could float on water if present in the pure form (Dawson et al., 1980).

CHLOROFORM

The behavior of chloroform or trichloromethane will be controlled by its vapor pressure. Chloroform will not persist in surface soils or aquatic systems because of its tendency to volatilize. Callahan et al. (1979) give a volatilization half-life in water on the order of several minutes to a few hours depending upon the degree of agitation. In the atmosphere, chloroform degrades rapidly as a result of photo-oxidation by hydroxyl radical attack producing phosgene and chlorine oxide. Callahan et al. (1979) give a photo-oxidation half-life on the order of several months.

While hydrolysis of chloroform in water is possible, the rate of degradation is slow relative to volatilization. Callahan et al. (1979) present a minimum half-life of 15 months based on experimental work by Dilling et al. (1979). A maximum half-life of 3,500 years is also given based on an extrapolation

VINYL
METHYLENE CHLORIDE

The behavior of ^{Vinyl} methylene chloride will be controlled by its vapor pressure. ^{Vinyl} Methylene chlorine will not persist in surface soils or aquatic systems because of its tendency to volatilize. Callahan et al. (1979) give a volatilization half-life in water on the order of several minutes to a few hours depending upon the degree of agitation. In the atmosphere, ^{Vinyl} methylene chloride degrades rapidly as a result of photo-oxidation by hydroxyl radical attack producing phosgene and chlorine oxide. Callahan et al. (1979) give a photo-oxidation half-life on the order of ^{a few hours} ~~several months~~.

While hydrolysis of methylene chloride in water is possible, the rate of degradation is slow relative to volatilization. Callahan et al. (1979) present a ^{hydrolytic} minimum half-life of ^{6-18 months} ~~18 months~~ based on experimental work by Dilling et al. (1979). A maximum half-life of 704 years is also given based on an extrapolation made by Radding et al. (1977). ^{hydrolytic} Oxidation and photodecomposition are not significant, if ^{it} they occur at all.

Sorption of ^{Vinyl} methylene chloride will be ^{slow} limited given its octanol-water partition coefficient. The extent of sorption is controlled by the organic matter content and surface area of clays (Dawson et al., 1980). ^{Vinyl} Methylene chloride mobility in aquatic systems will be controlled by water (rather than sediment) movement.

There is some uncertainty as to how persistent ^{VINYL} methylene chloride is in subsurface soils and groundwater. While hydrolysis can occur, it is difficult to estimate a rate of degradation. Given appropriate acclimation, biodegradation of ^{VINYL} methylene chloride is ^{very unlikely} possible but at a very slow rate. ^{existing evidence} indicates the compound to be resistant to microbial degradation.

^{5 T&T} ^{VINYL} The mobility of methylene chloride in subsurface soils and groundwater ^{will} be high.

PHENOL

Photo-oxidation, metal-catalyzed oxidation, and biodegradation probably all contribute to the fate of phenol in the aquatic environment. Photo-oxidation will gradually occur, but only in aerated and clear surface waters. Callahan et al. (1979) suggests, however, that phenol may be nonphotolytically oxidized in highly aerated waters that also contain iron and copper.

Hydrolysis and volatilization of phenol are probably not environmentally significant processes. There is a possibility that some volatilization can occur, but, once in the atmosphere, phenol would be rapidly destroyed by oxidation in the troposphere. Since sorption of phenol is limited, it appears to be highly mobile in soils and groundwater.

Based on its octanol-water partition coefficient, sorption of 1,1,2-trichloroethane is expected to be limited. Dawson et al. (1980) state that sorption of 1,1,2-trichloroethane will be proportional to the organic content of soils and surface area of clays. Thus, its mobility in aquatic systems will be controlled mainly by the rate of water movement rather than sediment movement.

The persistence of 1,1,2-trichloroethane in subsurface soils and groundwater will be controlled by hydrolysis. Biodegradation has been found to occur, but usually under anaerobic conditions as a result of reductive dehalogenation (Bouwer and McCarty, 1983). Thus, biodegradation will not be important in aerated subsurface soils and groundwater. The rate of biodegradation is difficult to estimate on a site-specific basis.

The mobility of 1,1,2-trichloroethane in subsurface soils and groundwater will be high because it has little tendency for sorption.

ETHYLBENZENE

The behavior of ~~ethyl~~benzene is controlled by its vapor pressure. ~~Ethyl~~^{gasoline}benzene will not persist in surface soils or aquatic systems because of its tendency to volatilize. Its estimated half-life in water is on the order of several hours (Callahan et al., 1979). ~~Photo-oxidation of ethylbenzene in~~

^{probably}
the atmosphere is rapid, with a half-life of about 15 hours
(Callahan et al., 1979); this value is inferred based on the
relative reactivity of ethylbenzene and reported conversion
rates for m-xylene and 1,3,5-trimethylbenzene.

^{in atmosphere}
Oxidation of ~~ethyl~~benzene readily occurs in the liquid phase,
but the process appears to be inhibited by the presence of
water (Stephens and Roduta 1935). Hydrolysis is not expected
to occur, according to Callahan et al. (1979). Thus, the
persistence of ethylbenzene in surface soils and aquatic
systems is largely controlled by volatilization.

Sorption of ethylbenzene may be a significant process and
ethylbenzene will presumably be adsorbed by sedimentary organic
material. Its mobility in aquatic systems may be controlled
by sediment movement.

Ethylbenzene persistence in subsurface soils and groundwater
will be high due to the insignificance of hydrolysis as a
degradation mechanism. In addition, oxidation appears to
occur only in the absence of water. Biodegradation is ^{probable} pos-
sible given appropriate acclimation of soil bacteria and
aerobic conditions (Claus and Walker 1964; Gibson et al.
1966).

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Rates of biodegradation are difficult to estimate on a site-
specific basis.

Additional RI
GROUNDWATER SAMPLING
PROGRAM STUDY PLAN

ECC SITE
Zionsville, Indiana

W65230.C3.00

December 11, 1984

GLT424/44

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- 2 SAMPLING LOCATIONS
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- 4 SAMPLING EQUIPMENT
- 5 SAMPLE HANDLING AND SHIPPING
- 6 SAMPLE CODES
- 7 HEALTH AND SAFETY PLAN

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Section 1
SAMPLING OBJECTIVES

The general objectives of the overall ECC groundwater sampling program are to acquire data that will assist the ECC project team in identifying hazardous substances present at the ECC site and in defining the extent of hazardous substance migration in the groundwater. The data generated from the testing of the samples will be used in the development of appropriate remedial action alternatives.

Phase I of the groundwater sampling program was conducted at ECC on July 18 and 19, 1983. Phase II was conducted on November 29 and 30, 1983.

The additional RI groundwater sampling program for ECC has been designed to continue to investigate spacial and temporal groundwater contamination. Of particular interest is potential movement of groundwater contaminants towards nearby ~~potential~~ wells and towards the Northside Sanitary Landfill.

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Section 2
SAMPLING LOCATIONS

The locations for collection of the groundwater samples are indicated in Figure 1. Following is a listing of the sample locations. All monitoring wells were installed as part of the REM/FIT program.

Groundwater

| <u>Well Number</u> | <u>Description</u> |
|--------------------|-------------------------|
| ECC- 1A | Shallow monitoring well |
| ECC- 2A | Shallow monitoring well |
| ECC- 3A | Shallow monitoring well |
| ECC- 5A | Shallow monitoring well |
| ECC- 6A | Shallow monitoring well |
| ECC- 7A | Shallow monitoring well |
| ECC- 8A | Shallow monitoring well |
| ECC- 9A | Shallow monitoring well |
| ECC-10A | Shallow monitoring well |
| ECC-11A | Shallow monitoring well |

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Section 3
SAMPLING PROCEDURES

The sampling of the ECC monitoring wells will be divided into three parts: 1) well opening and monitoring, 2) measurement of well volume and water level, 3) evacuation of static water and, 4) sample collection.

1. Well Monitoring and Opening

- a. Take HNU or OVA readings in the immediate vicinity of the well to establish background conditions.
- b. Carefully unlock and unscrew or lift the well cap from the well casing.
- c. Take HNU or OVA readings in the immediate vicinity of the well and within the well casing and well pipe.
- d. If there are any significant HNU or OVA readings near or in the well above background levels, cover the open well and back away.

- e. Review the Health and Safety Plan to determine the need for upgrading safety protection levels.

Continue work at the appropriate level of safety.

2. Measurement of Well Volume and Water Level

- a. Measure the well-casing inside diameter.
- b. Determine the static water level.
- c. Determine the depth of the well.
- d. Calculate the number of linear feet of static water (difference between static water level and total depth of well).
- e. Calculate the static water volume of the well as follows:

$$V = Tr^2(0.163)$$

Where:

V = Static volume of well in gallons

T = Linear feet of static water

r = Inside radius of well casing in inches.

0.163 = A constant conversion factor that compensates for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and pi.

3. Evacuation of Static Water (Purging)

Before a groundwater sample is obtained, the static water will be evacuated (purged) to ensure that the well water sample will be representative of the groundwater. The method used to purge the well will be dependent upon the equipment available and the accessibility of the well. An absolute minimum of five times the well's static volume is recommended for legal cases (EPA, 1977). Alternatively, the well can be purged until the evacuated groundwater temperature and specific conductivity reaches steady-state values.

Consequently, previous monitoring data indicates no significant groundwater contamination. The water removed from shallow monitoring wells during the purging process will be dumped on the ground.

4. Sample Collection

- a. Once the well has been purged a sampling pump and bailer will be used to sample the groundwater in the well. All sampling equipment will be constructed of stainless steel and/or Teflon.
- b. Sampling equipment will be cleaned between monitoring wells by sequentially washing the interior and exterior of the equipment with a TSP solution, an acetone solution, and a final distilled water rinse.
- c. Groundwater samples for extractables, organics, pesticides and inorganic analyses will be obtained from the discharge end of the pump. Samples for volatile organic analysis (VOA) will be collected manually with a stainless steel bailer. Samples from artesian wells will be collected directly into the sample bottles.

GLT424

Section 4
SAMPLING EQUIPMENT

The following equipment will be used for the ECC groundwater sampling program:

- o Peristaltic sampling pump with battery drive and plastic tubing.
- o Stainless steel 2 inch OD bailer.
- o U.S. EPA sample containers
- o Coleman sample coolers.
- o M-scope.
- o Decontamination equipment.
- o Camera and film.
- o ENU 101 Photoionizer or Foxboro OVA

GLT424/49

Section 5

SAMPLE HANDLING AND SHIPPING

All of the groundwater samples to be collected at the ECC site are expected to be low concentration samples. The following handling procedures will be utilized to satisfy chain-of-custody requirements.

1. The sample team will collect the groundwater samples, place the samples into the appropriate premarked sample containers, preserve all inorganic samples in the field and decontaminate the exterior of the sample containers in the field.
2. The sample numbers will be taken to a clean area for paperwork processing and packaging of the samples.
3. The preparation area team will complete the required paperwork for each sample, place the samples into the appropriate cooler, pack the samples in the cooler with ice and insulating packing materials, and place the appropriate completed paperwork inside the cooler cover.

4. Once the cooler is packed and a final check indicates everything is in order, the cooler will be closed and sealed with two custody seals and packing tape.
5. Sample coolers will be transported to the nearest Federal Express office and shipped via overnight delivery to the designated contract laboratory. Sample case number, number of coolers, number of samples and the airbill numbers will be telephoned to the SMO on the day following cooler shipment.

GLT424/50

Section 5

HEALTH AND SAFETY PLAN

The following health and safety plan (H&SP) has been prepared by CH2M HILL, specifically for the additional RI activities at the ECC site.

GLT90/83

Section 6

SOIL SAMPLING TRIP INSTRUCTIONS

A. PERSONNEL

ASSIGNMENT

Randy Weltzin

Surveyor

Jeff Keiser

Surveyor, Sampler

Mark Lepkowski

Sample Team Leader

Meg Morrison

Decon. Tech., Sampler

B. SITE DATA

Location:

Approximately 10 miles north of Indianapolis, Indiana, near Zionsville, Indiana.

Notes:

None available at the site.

Observations:

Much better!! All drums gone; all bulk liquids gone; all portable bulk tanks gone; contaminated lagoon water gone; pond backfilled; site capped and seeded.

Individual rooms at Red Roof Inn
(North) just off US 421
(317-872-3030) near Zionsville.

C. TENTATIVE SCHEDULE

| <u>Date</u> | <u>Time</u> | <u>Activity</u> |
|-------------|-----------------|---|
| 12/11 | 3 p.m. | Leave Milwaukee; drive to Indianapolis. |
| 12/12 | 7 a.m. - Noon | Arrive at site and set up decon. Calibrate instruments. Determine background conditions. Obtain supplies. |
| | 1 p.m. - 5 p.m. | Get what we forgot. Begin sampling and surveying. |
| <u>Date</u> | <u>Time</u> | <u>Activity</u> |
| 12/13 | 7 a.m. - Noon | Sampling and surveying. |
| | 1 p.m. - 5 p.m. | Sampling and surveying. Drive back to Milwaukee. |

D. EQUIPMENT

HNU - 1

Decon. Equipment - 1

Decon. Equipment - 1 Per Person

SCBA (Standby) - 1

Surveying Equipment - 1 Set

Decon. Equipment - 1 Hot Line Setup

Decon. Equipment - 1 Borehole Setup

D. ~~REQUIREMENT~~ (Continued)

Plastic Pails - 5

Tyveks - 50

Respirator Cartridges - 100

Booties - 50 Pair

Gloves, Rubber - 6 Pair

Gloves, Surgeon - 100 Pair

Ruler

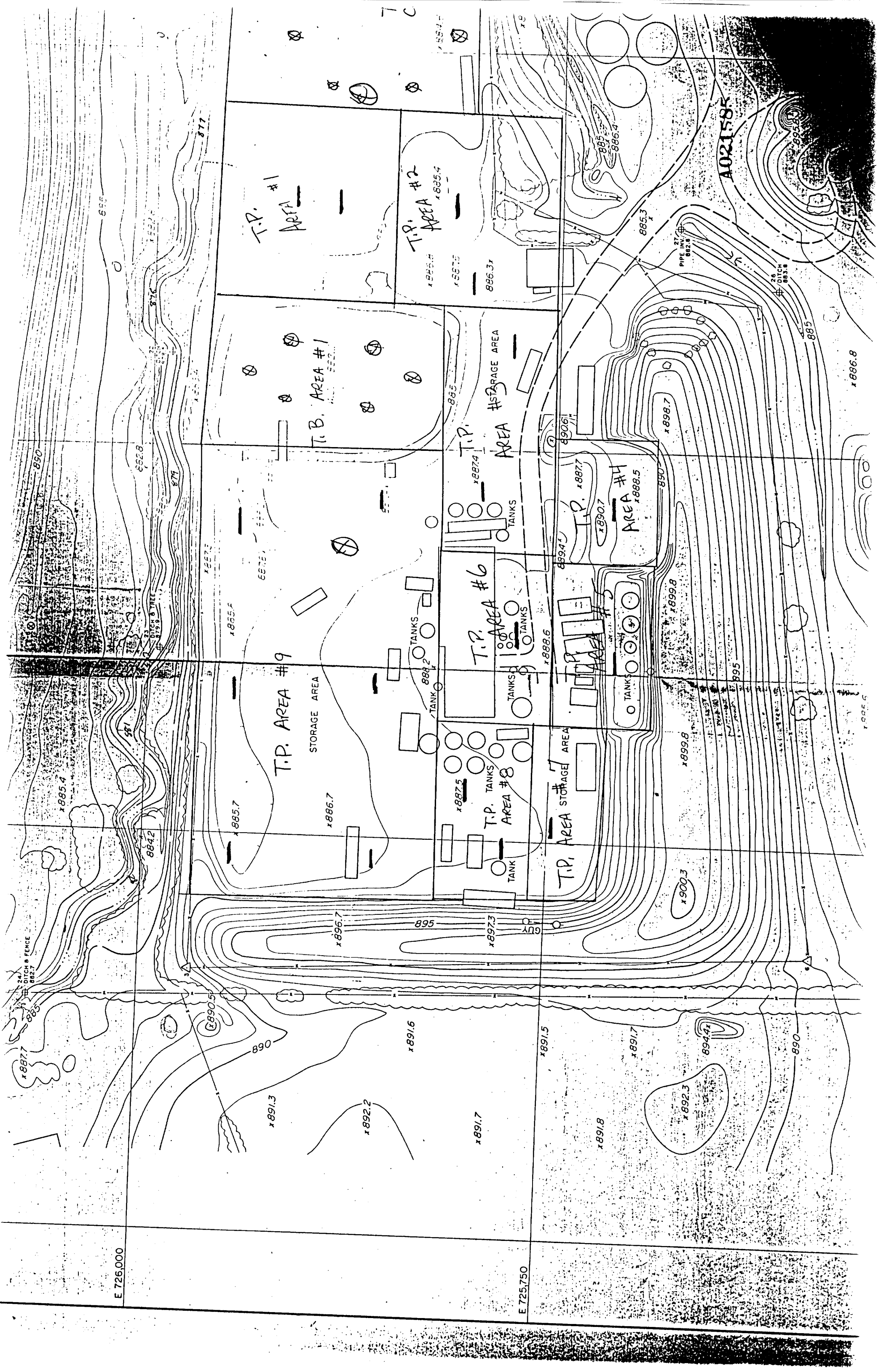
E. OBJECTIVES

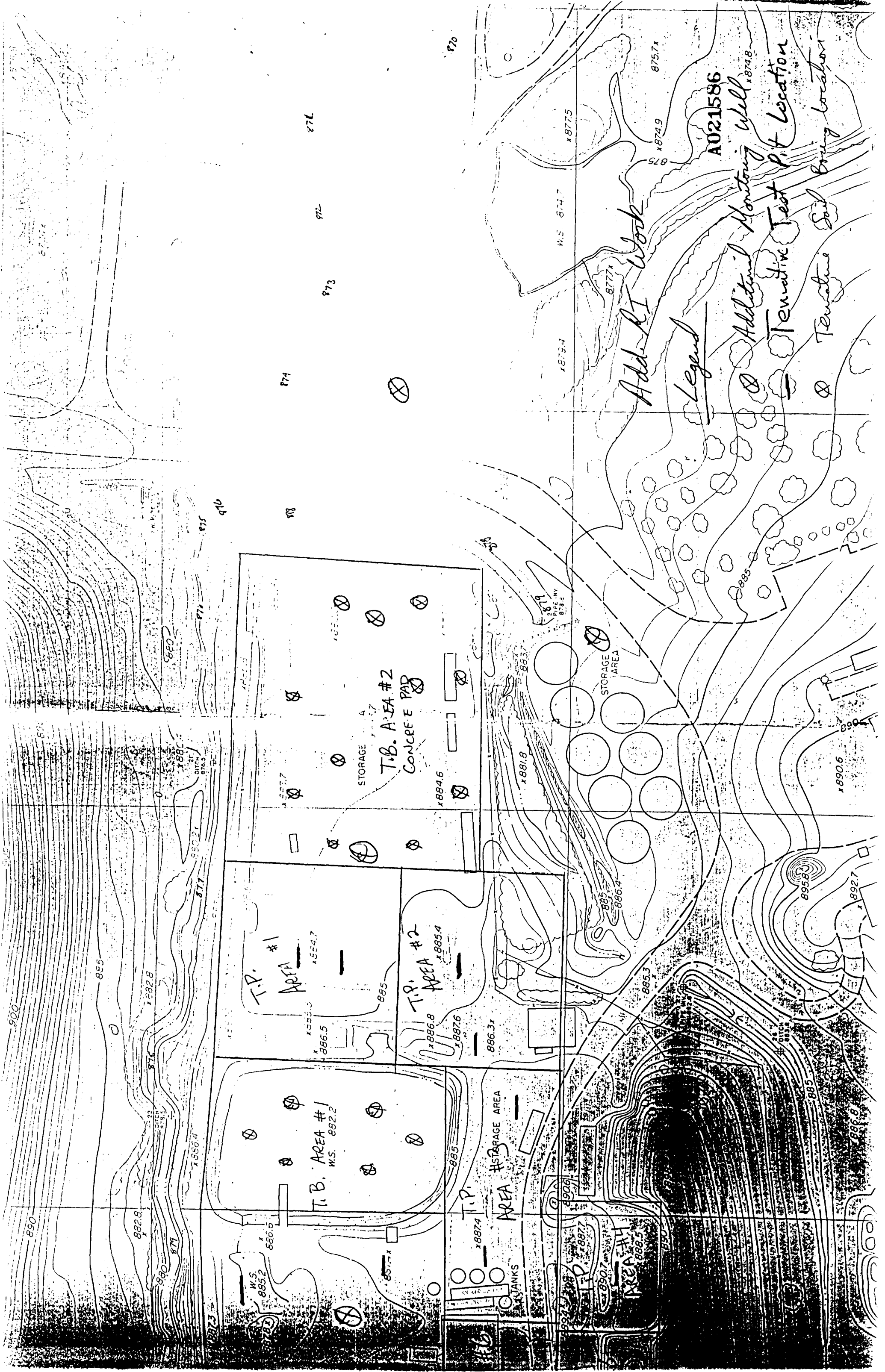
- o To delineate horizontal coordinates and elevations of monitoring wells.
- o To determine the depth of water in monitoring wells.
- o To ~~determine~~ sample ~~of~~ groundwater ^{and} standing ~~water~~ at the site.

~~and~~ accomplish the work safely and expeditiously (i.e., we do not have a lot of time or an expandable budget).

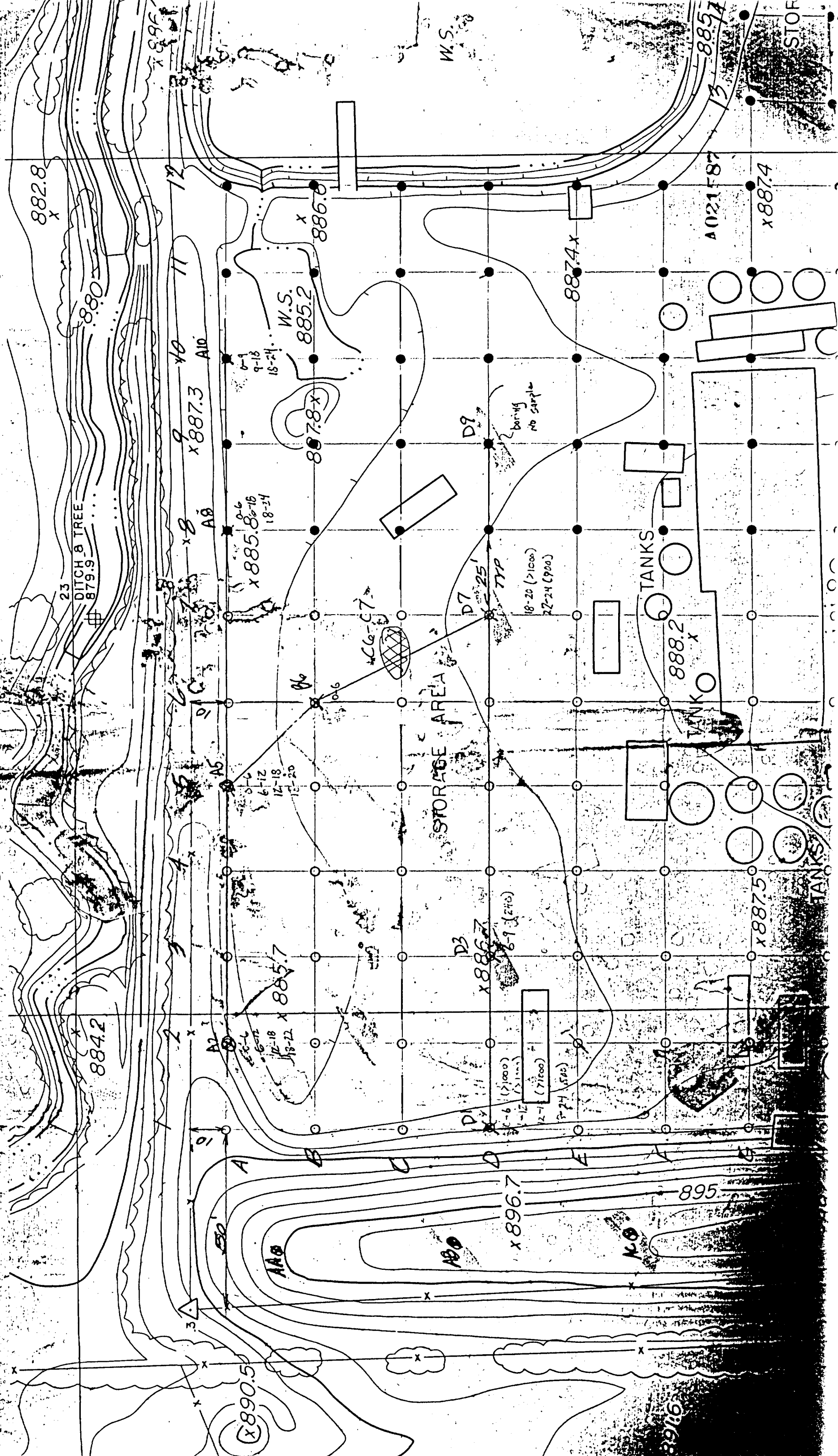
• send 15 low water samples to the CLP for
analysis.

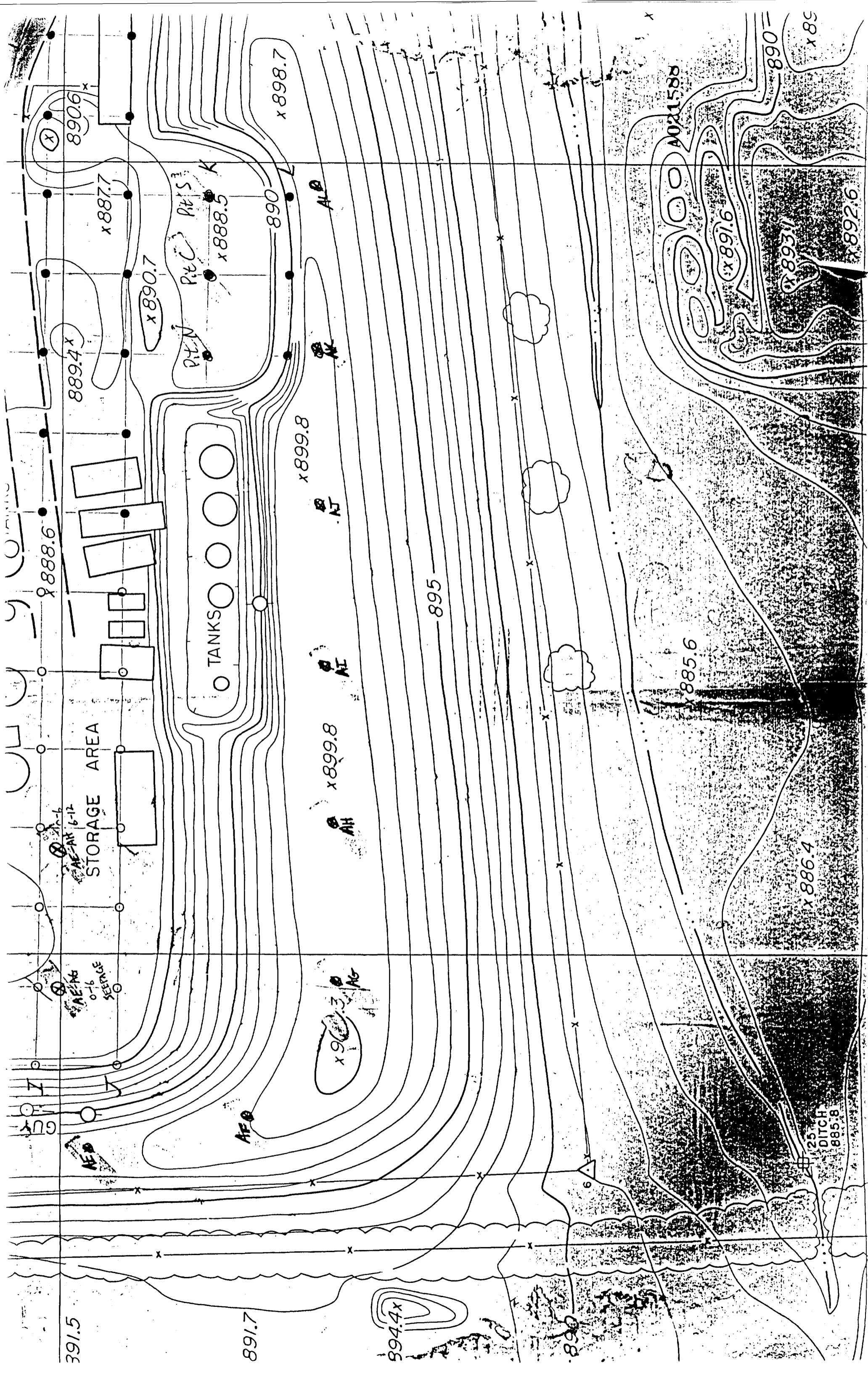
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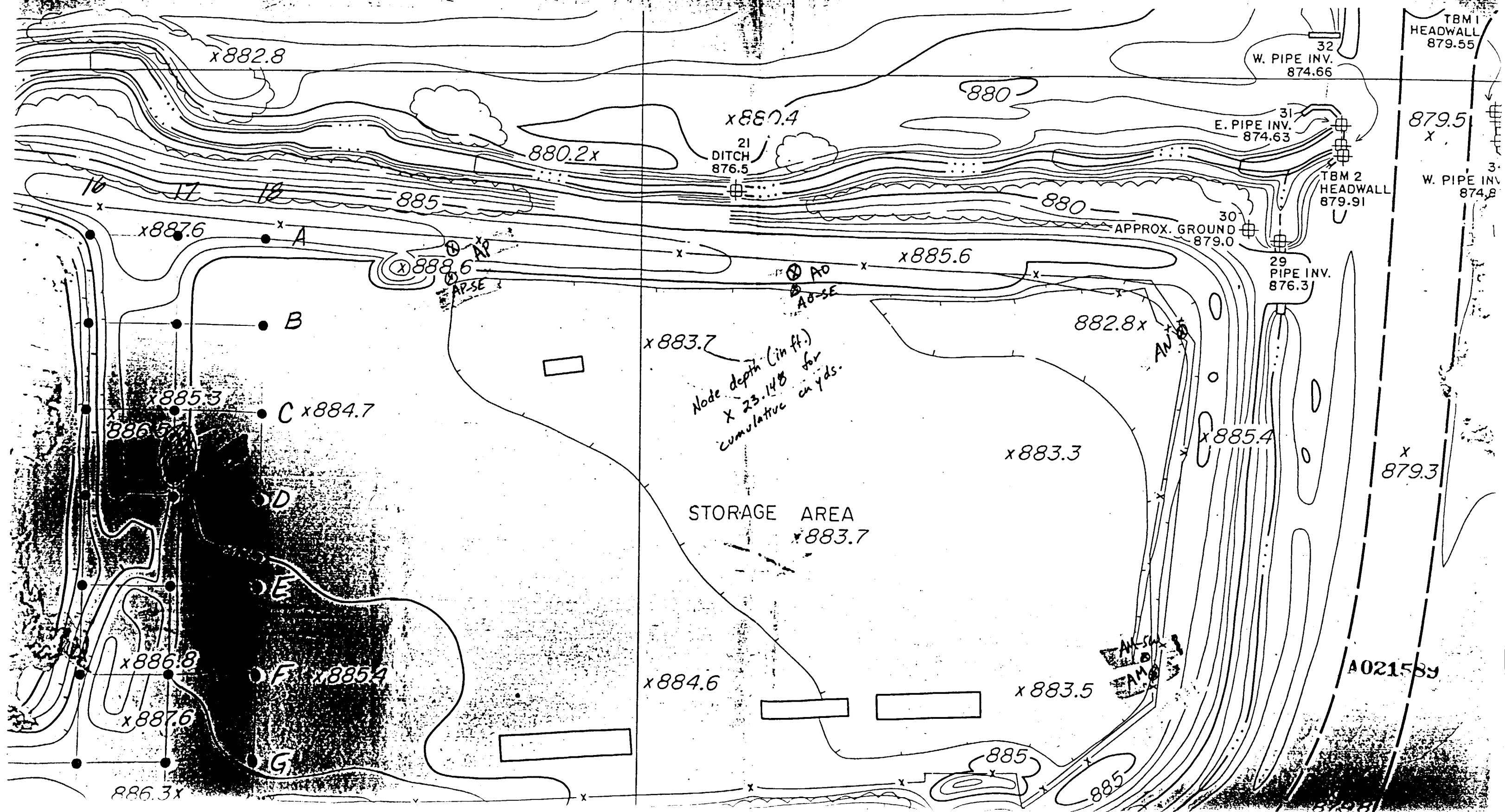


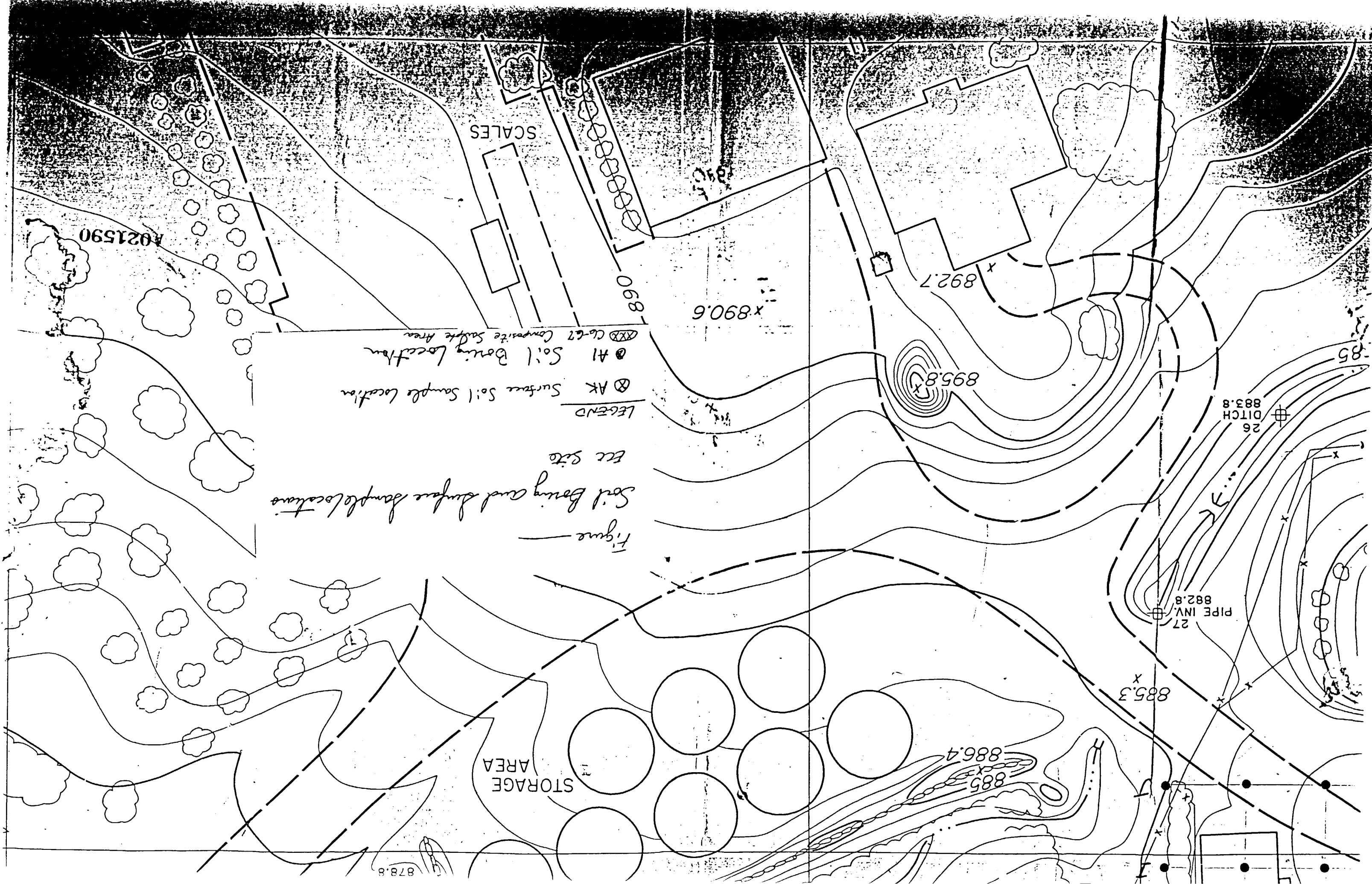


ENVIROCHEM
ZIONSVILLE, INDIANA









Additional RI
GROUNDWATER SAMPLING
PROGRAM STUDY PLAN

ECC SITE
Zionsville, Indiana

W65230.C3.00

December 11, 1984

GLT424/44

A021321

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| 6 SAMPLE CODES | |
| 7 HEALTH AND SAFETY PLAN | |

GLT424/45

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Section 1
SAMPLING OBJECTIVES

The general objectives of the overall ECC groundwater sampling program are to acquire data that will assist the ECC project team in identifying hazardous substances present at the ECC site and in defining the extent of hazardous substance migration in the groundwater. The data generated from the testing of the samples will be used in the development of appropriate remedial action alternatives.

Phase I of the groundwater sampling program was conducted at ECC on July 18 and 19, 1983. Phase II was conducted on November 29 and 30, 1983.

The additional RI groundwater sampling program for ECC has been designed to continue to investigate spacial and temporal groundwater contamination. Of particular interest is potential movement of groundwater contaminants towards nearby residential wells and towards the Northside Sanitary Landfill.

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Section 2
SAMPLING LOCATIONS

The locations for collection of the groundwater samples are indicated in Figure 1. Following is a listing of the sample locations. All monitoring wells were installed as part of the REM/FIT program.

Groundwater

| <u>Well Number</u> | <u>Description</u> |
|--------------------|-------------------------|
| ECC- 1A | Shallow monitoring well |
| ECC- 2A | Shallow monitoring well |
| ECC- 3A | Shallow monitoring well |
| ECC- 5A | Shallow monitoring well |
| ECC- 6A | Shallow monitoring well |
| ECC- 7A | Shallow monitoring well |
| ECC- 8A | Shallow monitoring well |
| ECC- 9A | Shallow monitoring well |
| ECC-10A | Shallow monitoring well |
| ECC-11A | Shallow monitoring well |

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Section 3
SAMPLING PROCEDURES

The sampling of the ECC monitoring wells will be divided into three parts: 1) well opening and monitoring, 2) measurement of well volume and water level, 3) evacuation of static water and, 4) sample collection.

1. Well Monitoring and Opening

- a. Take HNU or OVA readings in the immediate vicinity of the well to establish background conditions.
- b. Carefully unlock and unscrew or lift the well cap from the well casing.
- c. Take HNU or OVA readings in the immediate vicinity of the well and within the well casing and well pipe.
- d. If there are any significant HNU or OVA readings near or in the well above background levels, cover the open well and back away.

- e. Review the Health and Safety Plan to determine the need for upgrading safety protection levels.

Continue work at the appropriate level of safety.

2. Measurement of Well Volume and Water Level

- a. Measure the well-casing inside diameter.
- b. Determine the static water level.
- c. Determine the depth of the well.
- d. Calculate the number of linear feet of static water (difference between static water level and total depth of well).
- e. Calculate the static water volume of the well as follows:

$$V = Tr^2(0.163)$$

where:

V = Static volume of well in gallons

T = Linear feet of static water

r = Inside radius of well casing in inches.

0.163 = A constant conversion factor that compensates for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and π .

3. Evacuation of Static Water (Purging)

Before a groundwater sample is obtained, the static water will be evacuated (purged) to ensure that the well water sample will be representative of the groundwater. The method used to purge the well will be dependent upon the equipment available and the accessibility of the well. An absolute minimum of five times the well's static volume is recommended for legal cases (EPA, 1977). Alternatively, the well can be purged until the evacuated groundwater temperature and specific conductivity reaches steady-state values.

Consequently, previous monitoring data indicates no significant groundwater contamination. The water removed from shallow monitoring wells during the purging process will be dumped on the ground.

4. Sample Collection

- a. Once the well has been purged a sampling pump and bailer will be used to sample the groundwater in the well. All sampling equipment will be constructed of stainless steel and/or Teflon.
- b. Sampling equipment will be cleaned between monitoring wells by sequentially washing the interior and exterior of the equipment with a TSP solution, an acetone solution, and a final distilled water rinse.
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3-4

A021328

Section 4
SAMPLING EQUIPMENT

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- o Coleman sample coolers.
- o M-scope.
- o Decontamination equipment.
- o Camera and film.
- o HNU 101 Photoionizer or Foxboro OVA

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GLT424/49

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GLT424/50

Section 5

HEALTH AND SAFETY PLAN

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GLT90/83

Section 6

SOIL SAMPLING TRIP INSTRUCTIONS

| A. | <u>PERSONNEL</u> | <u>ASSIGNMENT</u> |
|----|------------------|-----------------------|
| | Randy Weltzin | Surveyor |
| | Jeff Keiser | Surveyor, Sampler |
| | Mark Lepkowski | Sample Team Leader |
| | Meg Morrison | Decon. Tech., Sampler |

B. SITE DATA

Location: Approximately 10 miles north of Indianapolis, Indiana, near Zionsville, Indiana.

Telephones: None available at the site.

Site Conditions: Much better!! All drums gone; all bulk liquids gone; all portable bulk tanks gone; contaminated lagoon water gone; pond backfilled; site capped and seeded.

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D. EQUIPMENT

HNU - 1
O₂/Explosimeter - 1
Rad Mini - 1
Dosimeter - 1 Per Person
SCBA (Standby) - 1
Surveying Equipment - 1 Set
Decon. Equipment - 1 Hot Line Setup
Decon. Equipment - 1 Borehole Setup

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D. EQUIPMENT (Continued)

Plastic Pails - 5

Tyveks - 50

Respirator Cartridges - 100

Booties - 50 Pair

Gloves, Rubber - 6 Pair

Gloves, Surgeon - 100 Pair

Ruler

E. OBJECTIVES

- o To delineate horizontal coordinates and elevations of monitoring wells.
- o To determine the depth of water in monitoring wells.
- o To ~~determine~~ sample ~~of~~ groundwater ^{and} ~~the~~ standing water at the site.
- o To accomplish the work safely and expeditiously (i.e., we do not have a lot of time or an expandable budget).

A021335

- o To send 15 low water samples to the CLP for analysis.

GLT90/91